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THE EDUCATION OF A GUARDIAN OF THE PEACE.

THE question of the role and attitude of the police in the face of popular disturbances is one that impassions public opinion to the highest degree. This latter shows itself in general very clearly hostile. It accuses the police of being always and in all cases odiously brutal, without reason, in the face of an inoffensive crowd, and of devoting themselves to useless repressions, and it shows its resentment by epithets of every nature, which it applies to the members of the force even in ordinary times.

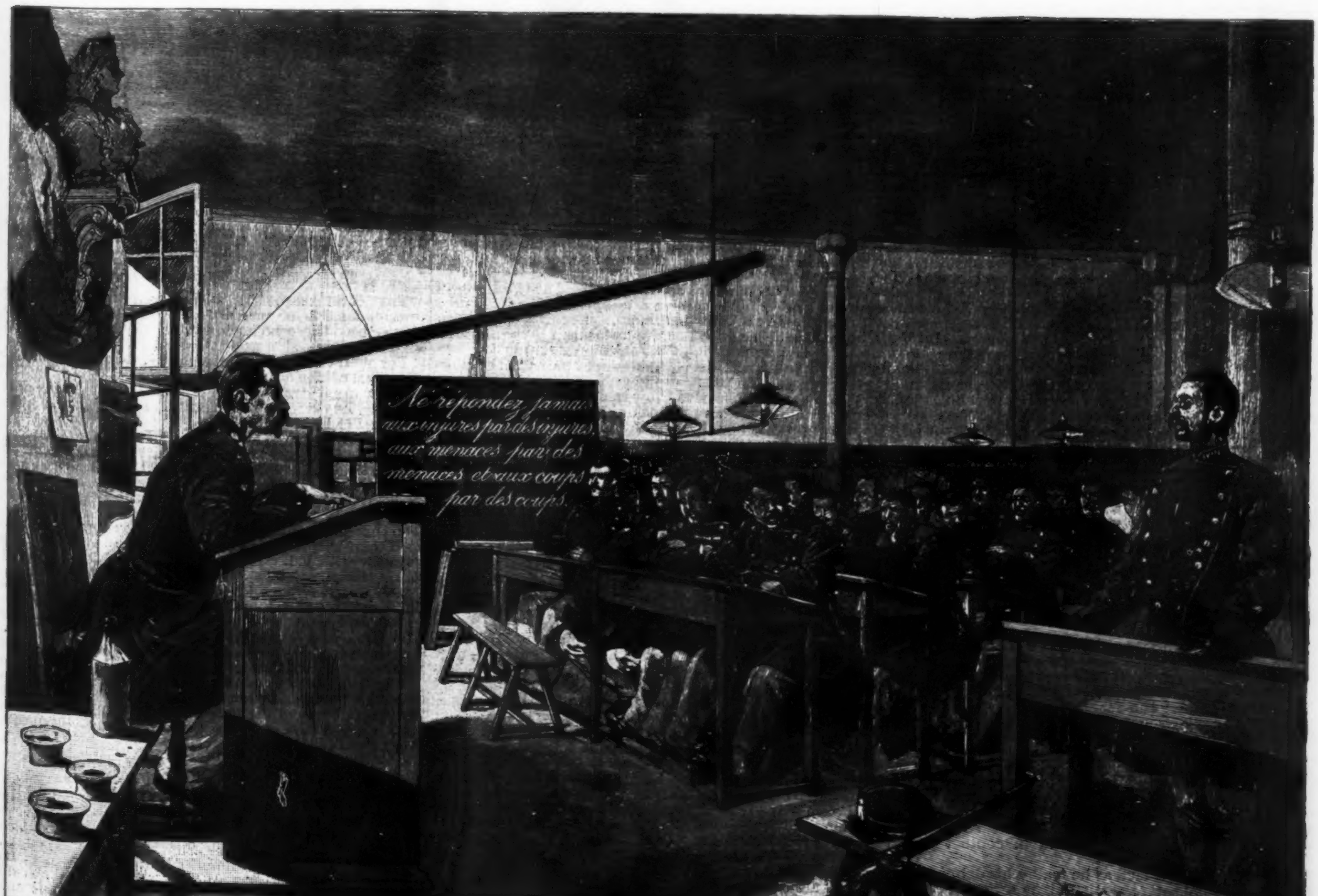
But on another side, also, the administration responds by taking up the defense of the *personnel* by exclaiming that it is an exaggeration, that it is a lie, and affirming that the men placed under its orders give proof, on the contrary, of gentleness and patience in the accomplishment of their mission or of their different "operations," to employ a term that has become almost official.

Between these two exaggerations, there is the truth of facts. The police are often brutal and cruel, and recent events have only too well shown it, and what is still more serious, they even kill. But it is necessary to say also that a mob is far from remaining impassible and calm in the presence of those whose mission it is to keep it within bounds.

A POLICEMAN'S HOME, PARIS.

Sometimes it insults them, excites them, dares them, and incites them to retaliation in the way of violence and brutality. However this may be, the guardian of the peace is always put on trial, for it is he who is the instrument of repression or combat, and here a question at once arises: What is exactly his role and what are his real feelings? Is he active or passive in a brawl? Does he follow an order? Has he learned a theory and a practice of the mob and of a disturbance? This is a problem of which it is interesting to seek a solution. A slight study of the man, of his recruitment and of his apprenticeship will perhaps lead us to a result.

First, as regards the man: In order to enter the police force, it is necessary to possess a great number of qualities, of which the following are the principal: The applicant must be strong and stout, neither too large nor too small, and must not be over 35



THE POLICEMAN'S SCHOOL, PARIS.

years of age. He undergoes, moreover, in this regard, a series of examinations of which the last is not the least characteristic. It is what is called the physical examination, and serves to show that he is neither too handsome nor too ugly. It is not permitted, in fact, to the guardian of the peace to be an insipid beauty, but it is not necessary either that he shall render his uniform grotesque and diminish the prestige of authority by a repulsive ugliness.

As for moral qualities, gentleness, politeness, and almost timidity are required of him. An old soldier, or but just coming from the military service, he will be required in his new functions to practice the discipline, the obedience and the respect for his superiors that distinguished him as a soldier.

It is almost useless to say that the most absolute morality also is demanded of him. We pass over the purely anatomical and medical characters that are ascertained before his admission—dynamometric force, circumference of the thorax, visual acuteness, etc.

Physically and morally, therefore, the guardian of the peace must be an absolutely perfect man, at once vigorous and gentle.

The men are recruited almost exclusively from the army. Many have been corporals, and some even sergeants and sergeants-major. Yet this rule is not absolute, and a door of entrance is also open to civil candidates. Here is the man admitted; he has undergone the various tests irreproachably. He is immediately incorporated and enrolled as in a regiment.

Within the first eight days he is clothed and armed, that is to say, a gun is given him, of which he carries only the saber-bayonet, the weapon itself having to remain at the arsenal, in the special magazine of the police, where it is carefully kept in repair by an armorer, and where he will find it at his disposal in case of need.

The picket of the guard of the barracks is the only one permanently armed, and mounts guard with the complete equipment. The guardian of the public peace therefore in reality remains or becomes a soldier, a street soldier, if you please. All that is wanting of the soldier is the permanent weapon.

On his arrival he is put in a brigade. In his brigade, the equivalent in number of the battalion, he will have over him now, as in the army, sub-corporals, corporals, non-commissioned officers, then officers—a lieutenant and a captain. It is the peace officer who commands him directly, and with whom he is in daily contact, and whom he will find ahead of him at the moment of action.

One thing, however, differentiates him from the soldier, and that is, that when his labors are finished he will be able, instead of entering the barracks, to go home, where he will throw off all the cares of his vocation in the company of his family.

Yet, because he is from the army and is honest, disciplined and gentle, it does not follow that he knows, as if by a sort of inspiration, his new service, which differs singularly from the other, and, just as he learned the preceding, he will have to learn this.

To mount guard, to stand sentinel, has nothing in common with the circular bear-in-a-cage promenade for long hours in succession around the same blocks of houses.

The street service of the new policeman differs essentially from the station service of the old soldier. In this regard all is new for him; he knows nothing, he has everything to learn. As a soldier he knows or has known his military theory by heart; as guardian of the peace it will be necessary for him to study his policial theory, all bristling, on the contrary, with more or less abstract documents.

How is he to be educated and taught his vocation? He is to be sent to school like a child in order to learn his lesson.

This detail is curious and little known. Created especially in 1883, the school of the guardians of the peace is called the Practical School of the Municipal Police, and has its habitation in the city barracks. This school offers the aspect of a parish one. All is there: the microscopic, badly squared desk which renders hump-backed the dirty inkstand of black mud, the names of the pupils carved in the wood, the huge closet in the rear, bazar of school furniture, the row of clothes pegs on the walls, the bust of the Republic, etc.

Then there is the blackboard, the basis of the edifice of policial instruction. The students have their eyes constantly fixed upon it. The laws, decrees and ordinances regulating the police are all written thereon, commented upon and explained. But, what before else is written thereon, what the white chalk traces thereon to perpetuity, are the very principles upon which is based all the theoretical and practical policeship. Look! "Never respond to injuries by injuries, threats by threats, blows by blows. Prevent and do not repress. Use gentleness and not force. Never take refuge behind a case of legitimate defense, but leave the weapon in the scabbard." And every day, at every lesson, the men who succeed each other at these same desks read these same phrases, which are explained to them and commented upon. A smile cannot be prevented upon thinking of what becomes of these evangelical maxims in practice.

Then these lessons upon the general principles that govern the police are succeeded by lessons upon the different street incidents in which they will be legally called upon to mingle.

From the carpet that is shaken up to murder, they are told that for them everything is a matter of talk, of intervention, but never of repression.

They remain thus in general from four to six months at school, under the ferule, bending over their desk and writing like schoolboys, while over yonder behind his desk, the corporal monitor reads to them a fragment of the regulations and laws, interrogating them in their place turn by turn.

At the end of this time they have finished their studies. This almost childish education makes a transformation in the old soldier. Well instructed from a theoretical point of view, he is less so in practice and has need of being formed in contact with the street.

Look at him, in fact, as he makes his debut upon the public thoroughfare. His gait is awkward, his arms swing, and his kepi on the back of his head, he strolls along or stops, answering with politeness and suavity, as if with a certain timid hesitation, the people who ask him questions of all sorts—trifling and sometimes even ridiculous.

Far from observing and watching, he appears to be gaping and thinking of the recommendations of the blackboard.

It is only in the long run that he perfects himself and becomes a good policeman. In sum, he has been taught merely administrative theory and suavity.

How does it come that this same man, whom we have just followed step by step, whom we have seen studying lessons like a child, and whom we have afterward met polished and almost timid in the street, undergoes a transformation at a given moment, and, instead of a mild and preventive "Move on, gentlemen," allows us, in a brutal vociferation, to hear these words: "Come, get along there, you, and quicker than that, too." How does it come that, becoming suddenly furious and as if mad, he attacks, strikes, wounds and kills, justifying and sometimes exceeding what he is accused of? Nothing, moreover, has prepared him for this, but, on the contrary, he has been taught another role. What, then, has taken place in him? The answer is delicate and complex. It is not in the deeds, but rather in the feelings.

It is with the policeman the same as with all men. Alone and isolated, he will show himself calm and patient; in a body, on the contrary, and especially in face of a crowd that he feels hostile, he changes front and becomes aggressive in his turn. The *esprit de corps*, the feeling of elbow to elbow, and the eye of the superior that is looking at him, all this combines to lead him to this result.

Finally, in order to be a guardian of the peace, one is none the less a man, and it is hard to remain impassible and calm under the injuries that rain at the same time as projectiles and blows. Then, when the measure is full, at a sign from his chief, he gives battle with all his strength, nothing will any longer restrain him.

The guardian of the peace has become a soldier again; leaving the responsibility to those who command him, he no longer thinks of anything but what he considers to be the duty of the moment. As policeman, he will have to repress and render himself master of the riot, and afterward, as a man, to take revenge for what he has just been made to suffer.

The action that takes place is directed in its broad lines by the chiefs, but in details is left to individual initiative. He has not been taught especially how he ought to act, how to use his arms and his weapons, and therefore he makes use of them as he can.

The anonymous author of the "Police at Paris," a small volume published by the *Temps*, has traced an interesting sketch of the manner in which he is made to operate.

Two methods, writes he, are practiced at the Prefecture of Police. The prefects adopt one or the other according to their temperament. The first consists in acting with large masses and closing up the affair at once. A popular demonstration is announced: two hours in advance, the brigades are made to take position upon the point designated as a rendezvous. When the rioters arrive they find the police in a dense mass and do not dare in general to begin a fight.

This process has the advantage of cutting short the promenades of the turbulent. But it is necessary to be an energetic prefect in order to have recourse to it. In fact, on the next day, we are certain to read in the hostile journals that the "police were looking for an opportunity," that "they were provocative" and it was "they who got up the riot." The proof, add these journals, is that there was not a "single tentative directed against the police."

This is the preventive method. The second is called at the Prefecture of Police the *louvoyante*. It consists in waiting until a few shutters have been smashed and a few panes of glass broken before intervening. Then the police are sent out in small squads. The turbulent are chased from one street to another. Here and there a few brawlers are arrested, then the men go back to the station. The next day, the columns are seen to form in other streets, damages to property are again waited for, and small squads of police are sent out. This occurs three, four or five days in succession. Then, as everything must have an end, no one comes out of his house any more, and one congratulates himself.

There is another method that may be qualified as the legal. It is the only one that the Prefecture of Police scarcely ever employs. It presents real advantages, however, and the bar of the court of justice always recommends it. It is the method of summonses and arrests *en bloc* after hemming in.

As may be seen, the tactics of the police in face of a riot are completely exposed.

Facts prove that the process that they prefer is the dispersion of gatherings through a charge and individual arrests of people one by one.

But since by this process it generally takes two men to make a single arrest, the brigades become ungarrisoned quite rapidly, and, in order to obviate this inconvenience, it is not without example that the prefects have recommended as few arrests as possible, so as not to deplete the columns.

"Shove back and disperse," such is then the order. It seems difficult to reconcile this maneuver with the theoretical principles given at the school of gentleness and persuasion. The officers are there, however, the man feels himself sustained and inspired, and, in order to charge, the saber has been unsheathed.

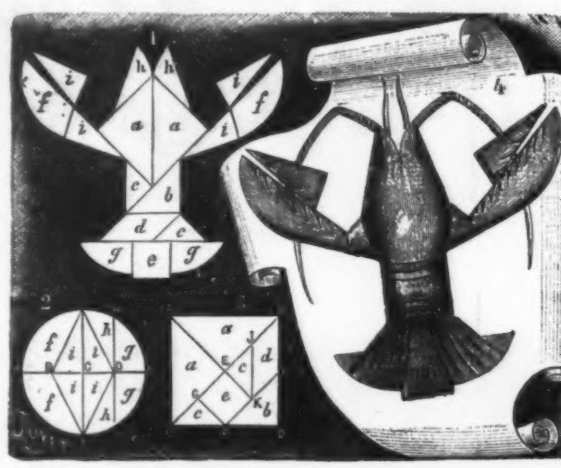
As the policeman cannot easily force back compact groups, and has the order to arrest as few as possible, he loses patience, his hand closes upon the hilt of the saber, and, provided the rioter resists, regretable scenes occur, which are still more serious if the resistance is greater. Seized then himself also with a sort of delirium of the mob, the superexcited policeman forgets theory and school, and entirely given over to his enervation and fury, answers injury with injury, threat with threat, and blow with blow. It is a genuine war that is waged, and the guardian of the public peace sees red. Nothing any longer arrests him. Running forward he upsets and treads upon women, kills men and butchers children, and the excited crowd flees.

So then, upon the whole, it is not coldly by tactics and maneuvers learned in advance that the guardian of the public peace is thus transformed. To that effect a whole series of circumstances is requisite.

But, the riot over, every one has gone home. The policeman becomes an isolated being again, and another modification immediately takes place in him. Impatience and anger have subsided with the intoxication of the fight.

He is now a good citizen who attends to the occupations of the household. He scarcely dares while eating to recount the outside incidents to his wife, who has anxiously awaited him all day; he avoids speaking of them. With his hard and calloused hands he gently caresses his child seated upon his knees, and who smiles at him. His coat unbuttoned, seated at ease before the table, he breathes happy to live, like the cat purring under his chair, without thinking that others lie over yonder upon the pavement who will never enter home again because of him.

Now he has already forgotten all. In the peaceful interior, only an insignificant detail—the end of a dusty boot protruding from beneath a curtain and the scabbard of a saber bayonet gleaming in a corner—evokes the idea of the ungrateful, perilous, and sometimes cruel business that the inhabitant of the house does outside.—*L'Illustration.*



THE GEOMETRICAL LOBSTER.

THE GEOMETRICAL LOBSTER.

THE crustacean that we serve up here to lovers of puzzles consists of seventeen pieces. The question is to assemble these latter in such a way as to construct a square on one side and a circle on the other.

For such construction, it will suffice to follow the indications of the accompanying figure.

Draw upon strong paper a circle of four centimeters radius. Lay off the horizontal and vertical diameters A E and G F.

Mark the points B and D, centers of A C and C E. Draw the four lines G B, G D, F B and F D, and then the vertical, H I, passing through D. The circle will thus be divided into ten parts. The square A B C D is composed of six pieces and its sides are 6¼ centimeters in length. Draw the diagonal C B, the line F I that joins the centers of the sides C D and B D, and then the diagonal A D, but stopping at K where it meets with F I. Join the point K with J, center of E B. Finally, join F with G, the center of C E.

Cut up the circle and square according to the lines of division, and ask an amateur to take the seventeen pieces and construct a lobster, and then to reconstruct the circle and square from which it was made. In the construction of the lobster, the piece *d* and two of the triangles must be turned wrong side outward. The circle and square may be cut out of red paper, upon which, after the lobster has been constructed, may be drawn the eyes of the crustacean, the rings of its carapax, etc. Antennæ of red paper also will produce a very good effect.—*Le Chercheur.*

THE STANFORD UNIVERSITY.

THE newspaper accounts of the estate left by the late Senator Stanford have started speculation as to the value of his endowment of the university which bears his name, says the San Francisco *Argonaut*. Few people have any definite idea of the actual sum of money represented by the property which will come into the possession of the trustees of the university when Mrs. Stanford dies.

The property consists of three pieces of land—Palo

Alto, 8,400 acres, of which a large portion is under cultivation, being planted in vines which have been found to suit the soil; Gridley, 22,000 acres, which have been planted to wheat, will probably be gradually planted in vines; and Vina, 59,000 acres, of which between 4,000 and 5,000 acres are planted in vines. Of these three the Vina estate is, of course, the most valuable. There are in round numbers 3,000,000 grape vines on the estate, which yielded last year 11,000 tons of grapes. When all the vines now planted are in full bearing, the product will be something like 20,000 tons of grapes per year; and the vineyard is growing from year to year. A large portion of the Vina estate is used for raising horses of all the various breeds, and other portions are employed as cow pastures, sheep pastures, and hog pastures. It is difficult to form an adequate idea of the money value of such land at the present time, and almost impossible to guess what it will be when a better knowledge of the peculiarities of soil and climate and the handling of the grapes will enable California wines to command the same price as the foreign product. But land which will grow five tons of grapes to the acre has a definite and well known value in France and Germany, and there is no reason why it should be different here. It is worth as nearly as possible $2,000 an acre in the Gironde and on the Rhine, and though it could not be sold for any such sum at present in this State, it will earn interest on that amount. Thus the Vina vineyard alone represents an endowment to the college of $8,000,000 and a present income of about half a million a year. This, it will be remembered, is exclusive of the Palo Alto property, the Gridley ranch, and the fifty-odd thousand acres of land at Vina not planted in vines. If all the land in the three properties which is suited to vine growing were planted in vines, it would represent the enormous sum of $200,000,000 and an annual income of over $11,000,000.

No university in America has anything like such an endowment. According to the college registers the leading universities are endowed as follows:

Columbia	$13,000,000
Harvard	11,000,000
Yale	10,000,000
University of California	7,000,000
Johns Hopkins	5,000,000

The endowment of the Leland Stanford cannot be added to the list, because no one can tell its real amount. The Vina vineyard represents $8,000,000 at present, with a possible extension to over ten times that amount in the early future; but no one possesses the information required to appraise Palo Alto or Gridley. It may be said, without fearing contradiction, that its resources are far in excess of those of any other educational establishment in the world, and that it will never need to deny itself anything, from a library to an observatory or a laboratory, on the ground of expense. It is quite possible that when the properties which are devoted to its support yield their full income, it will find it possible to abolish all fees for tuition and to reduce the charge for board below that which a pupil would cost at home.

HADRIAN'S VILLA.

AFTER Trajan, Hadrian's name stands prominently forward in connection with the arts. He restored many of the ancient temples which were falling to decay; he erected others in a style worthy of the best ages of the art; he completed the temple of the Olympian Jupiter at Athens, and enriched it with a statue of the god in gold and ivory. But the most extensive of his works in relation to the arts was the construction and storing of his celebrated villa, about eighteen miles from Rome. It is almost impossible to read any account of ancient sculpture without finding some mention of Hadrian's Villa, for the sculptures discovered there have been immense. It will not, therefore, be out of place to see what sort of place this may have been in its best days.

This villa was built on the plain at the base of Tivoli, about eighteen miles from Rome, from the designs of the emperor, mainly to contain the treasures of art which he had collected. When first built it more resembled a city than a villa, for it is said by some antiquaries to have been eight or ten miles in circuit; but this statement is a little too much for modern credence. But it is nevertheless certain that in no other part of Italy is there a mass of ruins of such amazing extent. Instead of being merely a villa, as we now understand the term, it comprised a lyceum, an academy, a pæcile, a vale of Tempe, a serapeon of Canopus, a stream called the Euripus, a library, barracks for the guards, elysian fields and numerous temples. Many of these were imitations of celebrated buildings or places elsewhere, and Hadrian seems to have wished to concentrate all the luxuries possible within this his unequaled country house. It was embellished with all the finest works that could be procured, whether the productions of ancient Greek artists or of those of his own time.

Some of the most interesting and valuable remains of antiquity have been discovered there, and even at the present day every fresh excavation that is made among these ruins restores to the world some object of interest.

Some of the Egyptian superstitions having been introduced into Italy about this time, they were mixed up with the existing forms of worship, and the gods of the Nile were admitted among those of the Romans. The example of the capital was soon followed by the smaller communities, and as the new worship was extended over the whole empire, a great demand arose for statues and other symbols of Egyptian deities and ceremonies.

The imitations of Egyptian figures and subjects which are found in Italy, and which particularly abounded among the ruins of Hadrian's Villa, may be assigned to this period. The numerous specimens of sculpture of the time of Hadrian that are preserved in modern collections are evidence of the high state of the arts. The statues and busts of himself and of the emperors who immediately preceded and followed him, as well as the portraits of Antoninus and Lucius Verus, exhibit qualities that would do honor to the best ages of Greek sculpture. There are two statues of Antinous in the museum of the Capitol, one treated in the Greek style, entirely naked, and the other with Egyptian attributes, which are particularly worthy of notice from the simplicity and beauty, united with grandeur, that pervade them.

It was by the orders of Hadrian that a change was wrought in a law concerning the portraits of private individuals, and which change led to the fashion of having portraits in statuary in the houses of all the noble and opulent citizens. In the villa at Tivoli, Hadrian placed the statues and busts of all his living and deceased friends.

The favorite architects employed by Hadrian in his great works were Apollodorus and Detrianus; but all attempts to discover the names of even a few among the many sculptors who must have been employed by him have proved unavailing. How far Hadrian may be termed the Pericles of Roman art it would be difficult to say without knowing the degree to which he encouraged native artists to add to stores already existing; but he certainly seems to have been the most munificent patron of art that Rome ever had. With him the great impulse ceased, and neither the patronage nor the skill seem ever after to have been forthcoming to so great a degree for the production of fine sculptures.—*The Architect.*

SOME EXPERIMENTS WITH "FIREPROOF" MATERIALS.

IN March we referred to some tests to which various "fireproof" materials had been subjected at Berlin under the auspices of the Royal Police Fire Brigade of that city. The experiments, which had actually taken the form of a competition for honors and premiums between different makers or inventors of fire-resisting specialties, were proposed by the Amalgamated German Insurance Companies as far back as 1889 on the occasion of the "Accidents Prevention Exhibition" held in Berlin that year, and it was at that time that these institutions subscribed the necessary funds for the money prizes which were to attract the trade and cover the unavoidably heavy expenses. The main object of the promoters having been to arrange their experiments as "naturally" as possible, some years had to elapse until a suitable site for operations could be found, and it was not until the municipality of Berlin last year offered to put an extensive warehouse block at their disposal, that the preliminary preparations for the series of "fires" they proposed having could be taken in hand. The warehouse in question, which was destined for demolition on account of some street improvements, was admirably suited for the purpose; and after a careful reconstruction of the interior with the various materials and fittings the competitors wished to have tested, appeared to be almost indestructible by fire or water.

According to the official report which has now been published, a committee of eleven had to act as assessors, this committee consisting of architects, engineers, and fire brigade officers brought together from different parts of the country. Herr Stude, the late chief officer of the Berlin Fire Brigade, whose untimely death we had to report a few weeks back, was chairman to the committee; Herr Reichel, a senior officer in the same force, acted as honorary secretary, and was responsible for the general management of all the arrangements on the site of operations. There were eighteen competitors, including the Berlin Fire Brigade (*hors concours*), whose officers wished to demonstrate the very satisfactory resistance of the ordinary building construction, if only conscientiously and correctly carried out.

Some five months were at the disposal of the competitors for the reconstruction and fitting of the warehouse, and three days were set aside for the experiments. Prior to commencing the actual tests, the assessors, together with a number of invited experts, representatives of the technical press, fire offices, and government departments, carefully examined the exhibits, officers of the fire brigade explaining all details as to construction, supposed qualities of the materials, etc. The assessors and visitors found the warehouse had been very cleverly divided up in such a way as to facilitate examination of the individual exhibits intended for the special protection of certain trades, etc., without, however, interfering with the general or more severe tests these exhibits had to undergo together with other materials. Besides the different classes of living rooms and bed rooms, there was a retailer's shop, a general warehouseman's floor, carpenters' and frame makers' shops, an oil and colorman's store, and even a mineral oil depot, all most "naturally" arranged, and everywhere, even in matters of minute detail, it was obvious that, as far as it was in Herr Reichel's power, great pains had been taken to insure *bona fide* results. The tests were taken in hand systematically, first in the smaller, then in larger "risks," care being taken to let the various fires also originate as "naturally" as possible; finally, several floors and the staircase were set on fire at once, and a warehouse fire in its advanced stage represented.

Care was taken to subject the exhibits to the temperatures, irregularities of temperature, sudden shocks by falling weights or jets of water, etc., which generally occur at conflagrations, and it is well to note that in nearly every case it was possible to take fairly exact observations. The instruments at the disposal of the assessors could take temperatures to a height of 1,460 deg. C.; the weights, momentum, and direction of fall were approximately calculated; the force of the different water jets was taken from manometers, and the times by stop watches. Directly after each test was completed, there was again a careful examination of the exhibits, accompanied in some cases by entire dismantling of the objects, and even afterward by analysis; and it was then that among the valuable technical results arrived at, some object lessons could be learned as to the ways in which the over-ardent patentee tries to prove the value of his wares in anything but a fair way. Doors supposed to be of some patent fire-resisting material, and that alone, were found to have inlays of silicates of cotton; ceilings had inlays of asbestos where certain patent plasters were supposed to be alone withstanding the flames, etc. One competitor, whose exhibit was very properly lauded, but who was very prone to these makeshifts, had even to be "most seriously recommended" (so the report sarcastically puts it) to learn to have more confidence in his very excellent wares before offering them to the general public.

It would naturally lead us too far to describe the many exhibits and numerous experiments in full, and we can only refer to such as are likely to call for special attention, either, on the one side, for very satisfactory, or, on the other side, for unexpectedly unsatisfactory, results obtained. As these extreme results were for the most part obtained with exhibits intended for the safe division of separate risks, we shall limit our descriptions to this class of tests, leaving the trials with staircases, fireproofing of columns, uprights, etc., for a future occasion, as some further experiments of this class are intended to be made later on.

Perhaps the most remarkable experiments with satisfactory results were those with a patent fire-resisting glass, shown by Messrs. Siemens, of Dresden. The assessors have found it to be most suitable for any skylight or window necessary in a division between separate risks, as it will resist heat of 1,300 deg. C. for half an hour and more, bearing all manner of shocks, the sudden changes of temperature spoken of, and other strains, without ap reciable damage. This material may be safely expected to limit the extension of any ordinary fire during its first and most critical period.

Great care must, however, be taken in fixing plates of the Siemens glass, as it has a tendency to expansion or bending under certain circumstances when in iron frames, in which case openings are formed between the glass and iron through which flames can pass. The maximum size of the plates is 80 centimeters by 1·20 meters, or, roughly, 2 ft. 7 in. by 3 ft. 3 in., the thickness varying according to the probable maximum pressure they have to resist.

The most interesting experiments with a negative result were those with a floor by the so-called "Isothermal" Company, of Berlin. Fig. 1 shows a section

Fig. I

through a part of this floor; the girders alternately support the floor alone or both flooring and ceiling; the flanges of the latter carry the half inch magnesite plates (marked *a a*). Concrete (see *b b*) is filled in between the girders; the ceiling below (*c c*) is of a similar mixture on wire netting, while the floor proper (*d d*) is apparently of cement alone. This "Isothermal" floor has of course been advertised as indestructible, and many authorities have approved of it on account of the improbability of irregular expansion and the protection afforded to the concrete by the plates. A fire which burned forty minutes and had at no time a higher temperature than 1,000 deg. C., however, made great havoc of the exhibit, to such an extent in fact that nothing but the girders, badly twisted, remained in position. The floor had not even been tested with falling weights, and when touched by a stream of water from below while in a heated condition, had not even resisted the ordinary water pressure used from a hydrant for extinguishing. Tried from above as to its waterproof qualities when the top surface was damaged, similar unsatisfactory results were obtained. This floor, which was constructed essentially of iron with non-conductors on a theoretically correct principle, only too plainly showed how very necessary a *bona fide* test is for the *savant* who would rely on calculations alone, and is too prone to forget actualities. The girders, which covered a span of 6 meters, or 19 ft. 8 in., were only 50 centimeters, say 19½ in., apart.

Another floor, also essentially of iron, with non-conductors, contrasted strangely with the "Isothermal" exhibit. This one was known as "Kleine's" and shown by Messrs. Wigankow, of Berlin. Figs. 2 and 3 give

Fig. II

two sections through a part of this floor. The girders support both floor and ceiling. The flanges carry slabs (*a a*) made of a light Rhenish brick, cemented together and well tied with iron bands. The space between the girders is then filled up with slag (*b b*), the floor and ceiling proper being in cement. The assessors report this floor to be fire-resisting to a high degree. The fire which attacked it from below for three quarters of an hour, showing temperatures of over 1,100 deg. C., did not affect it to any appreciable extent. It is true that the steam fire-engine which played on it from below brought down some pieces of the cement ceiling, which damage, however, in no way affected the resistance of the slabs. Shocks

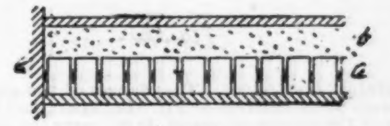


Fig. III

and weights up to 3,200 kilogrammes on the square meter were tried without effect, whereupon the cement on the floor was broken to try if the slabs were water proof, and satisfactory results likewise obtained. The distance between the girders was 83 centimeters, or 2 ft. 8 in., the span for the girders 5·80 meters, or about 16 ft. 4 in. The expression "thoroughly fireproof" was used in the criticism of the assessors; but this expression, as the late Herr Stude explains in the intro-

duction to the report, should always be read "as fireproof as possible." The maximum resistance required of any so-called "fireproof" material should practically be that of one hour's duration against fire of an average temperature of 1,000 deg. C., with a maximum temperature of 1,500 deg. C. Such resistance is generally sufficient to allow for the extension of a fire from one risk to another being stopped by trained men with the appliances, taking it for granted that the outbreak would not even be noticed until the average temperature mentioned had been operating some twenty minutes. The primary stages of the fire, the smouldering, etc., prior to a current of air fanning it, when a "light" would almost invariably be shown, should not affect a piece of "fireproof" construction to any appreciable extent. Not until the "light" is shown should the strain commence, and such a "light" is generally noticed in time to bring the first skilled assistance to the spot within half an hour of its first appearance.

A patent flooring by Messrs. Stolte was also spoken of by the assessors as thoroughly "fireproof." Messrs. Stolte are specialists in the preparation of various kinds of "cement plates." These they use for walls and doors as well as for floors. Their curved plates, which are made as light as possible for flooring, are illustrated in Fig. 5. Figs. 6 and 7 show how they can

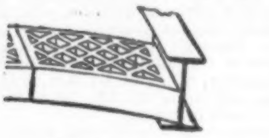


Fig. V

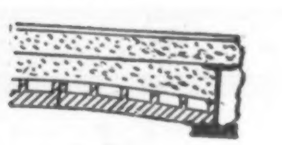


Fig. VI

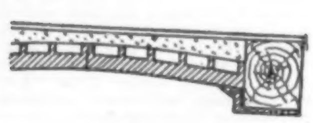


Fig. VII

be carried both by joists as well as by girders. The curved plates are either 2 or 2¼ in. thick. In Fig. 6 they rest on the flanges of the girders, the lower faces of which are protected by small "cement boards" held in position by iron bands. In Fig. 7 they rest on small L irons screwed on to the joists, the lower surfaces of which are protected by cement work. In both cases the space between the girders or joists is filled with sand, and an ordinary board flooring used. Fires of one hour's duration, with an average temperature of 1,000 deg. C., had no noticeable effect on these floors. The plates in one or two cases showed slight cracks at right angles to the bearers, without, however, decreasing the stability. The customary tests with shocks were tried without avail; streams of water from the fire engines had no effect. Heavy weights were tried, a load of 10,370 kilogrammes on the square meter eventually breaking one of the plates. The distance of the girders from one another is, unfortunately, not stated, but may be taken approximately at 80 centimeters, or about 31½ inches.

Messrs Mack, of Ludwigsburg, in Wurtemberg, who have a good repute for their excellent "gypsum boards," exhibited several floors which, according to the assessors, could likewise be termed "thoroughly fireproof," but were unfortunately somewhat susceptible to any contact with streams of water from below. Figs. 8 and 9 explain the construction of

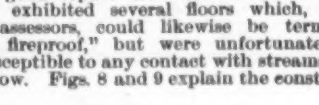


Fig. VIII.

Fig. IX.

the "girder" floor tested. The flanges of the girders (which are 83 centimeters, or 2 ft. 8 in., apart, and have a span of 5·80 meters, or about 19 ft.) carry the plates (*a a*); the space between the girders is then filled up with a light "pumice" concrete (*b b*), the floor proper being rendered in Portland cement. The ceiling proper is of ordinary mortar work, the lower face of the girders which it covers, however, being first prepared with wire netting. The numerous shocks and other trials which the floor had to undergo during the forty minutes a fire of an average temperature of 1,100 deg. C. raged below, had no effect; weights of 1,000 kilogrammes were tried with little result, but a jet from the steam fire-engine easily knocked off part of the lower surface. The plates are supposed to contain as large a percentage of cork as of gypsum, bamboo rods and hair keeping the various materials together.

While Messrs. Stolte's, Messrs. Mack's, and the "Kleine" exhibits described are classified as *bona-fide* composite floorings, the "Monier" floor, of which Fig. 10 shows a section, is generally classed with the concrete arches, although it is also essentially a composite

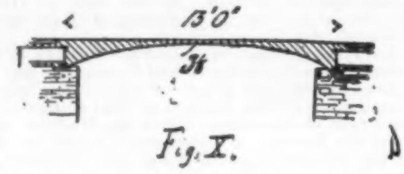


Fig. X.

construction—*i. e.*, a combination of cement with a framework of wrought iron bars of about ¼ in. in diameter, and mostly supported by girders. The dimensions of this "Monier" exhibit, which had been put before the assessors by Messrs. Waysz & Co., of Berlin, are marked on the illustration. The series of tests to which the "Isothermal" and other floors had been subjected were repeated, the average temperature in this case being again 1,000 deg. C., the loads on each square meter as much as 2,613 kilogrammes. No appreciable damage was done, and the assessors were able to express their confidence and entire satisfaction by reporting the exhibit to be "thoroughly fireproof." It would, perhaps, be well to remark that the report was not based on one experiment alone. As in all the cases described, there were several exhibits, but, as before said, space prevents taking notice of any but the most important ones.

The composite floors described were practically all intended to be used with iron girders, although Fig. 7 showed how a joist could in one case be substituted. The two following floors (see Figs. 11, 12 and 13) are now essentially such as are designed for joists alone, and where no iron, but wood only, with non-conductors, is used.

The floor illustrated in Figs. 11 and 12 is protected from below by a very carefully prepared combination

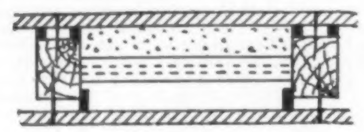


Fig. XI

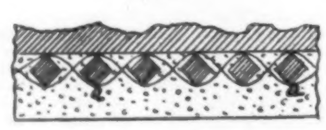


Fig. XII

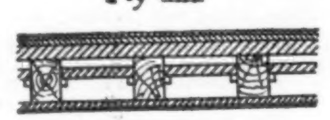


Fig. XIII

of plaster and wood lathing, the former a patent composition, the latter well interlaced with wire to prevent any change of position. This lath and plaster work, if we may so call it, is kept some distance from the lower surface of the joists and pugging, the space between being well ventilated. The pugging (a fibrous plaster one, we believe) carries a layer of loam, and the floor proper above is of cement on lath work, arranged similarly to that of the lower surface. The greatest pains were again taken to damage this floor, and a fire with an average temperature in this case of as much as 1,250° to 1,300° C. was kept up half an hour. The only noticeable effect, however, was the falling off in some few places of bits of plaster just below the extreme points of the lathing (*a a*), the lower surfaces of which were then found to have been badly charred. At no point had the lath and plaster work been opened either by the fire or water so as to allow the flames to touch the joists or pugging, though in one or two instances slight cracks, probably occasioned by change of temperature, were visible. During the fire, among other tests, a succession of weights of 50 kilogrammes were dropped on to the floor from different heights, but no damage was caused by them except a breakage of the upper surface. Even when this surface was broken, the floor also showed itself to be entirely waterproof from above—in fact, the exhibit in every way so thoroughly satisfied and astonished the assessors that its success ranked next to the Siemens glass we have spoken of above. Herr Schubert, of Breslau, is the maker of this floor, and the patentee of the lath and plaster work, which was also, bye the by, tested with equally good results as a protection to walls, etc.

The floor shown in Fig. 13 was exhibited by Messrs. Mack, of Ludwigsburg, whose "girder floor" we have already referred to. In this case the patentees used thin gypsum "boards" and plaster instead of the 4 in. hollow "plates." The joists, the surfaces of which had been well planed, were protected from below by 1¼ in. "boards," the pugging was of 2 in. "boards," the space in between being well ventilated, and the floor proper of 2¾ in. "boards," with 1 in. of a patent plaster above.

The boards are comparatively light, and their composition is supposed to be somewhat similar to Wilkinson's fibrous slabs. In this case the fire lasted one hour, the mean temperature being 1,100° C. The result was that the whole of the lower surface, *i. e.*, the thin boards which formed the ceiling proper, had fallen down, the heat having caused the primary damage and weakened the holding power of the joists, and a stream of water having brought about the actual collapse. The joists were severely burned, but not to such an extent as to let the well-weighted floor give way. The pugging had offered resistance, and the fire had not been able to pass to the risk above. According to the assessors this floor, though badly damaged, would still be practically classed with the "fireproof" ones. It had offered resistance for an hour, and taking it for granted that substantial joists were used, there was no reason to believe that the system, with its well-laid pugging and flooring, would give way under the strains that it would be reasonable to expect this class of flooring to withstand. The susceptibility of the Macks' exhibits to water damage was, however, again much remarked upon.

Walls, floors and the protection of the necessary openings in them are the parts of a building which have to be considered most in the selection of fire-resisting materials. A "fireproof" staircase, however safe, will be useless if smoke enter it from an unprotected opening. In cases like the warehouses of St. Mary Axe, which have lately been destroyed, the use of strong walls is general on account of the loads they have to support; good planning, with a careful division of risks, can then render a block practically safe if only the right material be chosen. The experiments with floors, described above, should aid the selection of horizontal divisions, as there were a number of positive results, and the Siemens glass is a good example of the materials suitable for the protection of window openings and skylights, without using the makeshift shutters which generally remain unclosed through sheer negligence.

As regards the protection of door openings, the Berlin tests can, however, scarcely be said to have been as instructive as we should have wished, excepting in a negative sense, as there were several interesting cases of substantial-looking constructions not coming up to the assessors' expectations. An ideal "fireproof" door (which would, however, probably also be left open as often as the less reliable one) should, like a floor, resist a fire of 1,000° C. at least one hour, withstanding sudden strains up to 1,500° C. It should then be absolutely smokeproof, and not be ever affected to such an extent as to be immovable when in a heated condition. The greatest fault for a door would be its susceptibility to bending out of shape, as the slightest twist allows smoke and flames to pass through the opening.

A door by Messrs. Schubert, the body of which was of wood with a light iron framing, though "fireproof," was quite impracticable on account of its inconvenient weight. The wood was protected first by a layer of earth, then by a layer of asbestos, on this some wire netting which held a thick layer of cement work. The door, which was 6 in. thick, measured about 3 ft. × 6 ft. It had to withstand a fire of 1,000° C. for an hour and a half. A second door by the same firm was of magnesite plates of 1 in. thickness. The magnesite was visibly affected by the same test, and bent to such an extent that the room it was to protect was soon filled with smoke and caught fire.

Another door, by Messrs. Violet, of Berlin, of which much was expected, was likewise a failure. Fig. 14

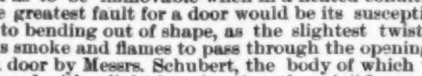


Fig. XIV.

illustrates this door, which shows an iron frame (*a a*) with a double layer of boards (*b b*), protected by iron plates (*c c*). The iron plates, expanding, bent outward, leaving the wood unprotected. The door almost at once showed itself to be anything but smokeproof, and after about half an hour's fire of 1,000° the flames burst through it. Strange to say, the frame neither bent nor jammed, and if the rims of the plates had been better protected and some non-conductor placed behind them, better results would no doubt have been obtained. The door measured 76 centimeters by 1·86 meters, or 30 in. by about 6 ft., and was about 1¼ in. thick.

Messrs. Huber & Co., of Breslau, exhibited a door measuring 90 centimeters by 1·90 meters, or 35½ in. by about 6 ft. It had a thickness of about 1⅜ in., and, as in the case of Messrs. Violet's door, was unfortunately fixed in an L iron wall frame. Fig. 15 explains

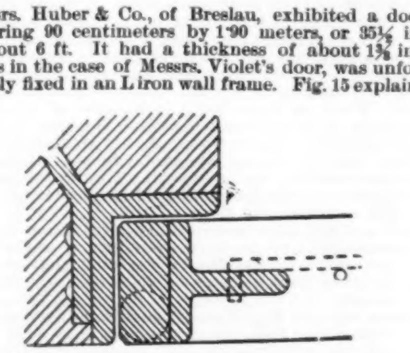


Fig. XV.

the construction, the part between the T irons being "Monier" work (*a a*), *i. e.*, cement on framework of ¼ in. iron bars (*b*). The Monier surface withstood a fire of 1,100° C. splendidly for forty minutes, but the door as a whole bent badly, smoke almost immediately entering the room, and the flames soon having a free passage into it.

Uncertain results were obtained from some doors shown by Herr Kuhlewein, of Berlin. These, the largest exhibited, were not let into rabbets in the openings, but simply covered them. They consisted of light iron framework held together by metal bands and covered on both sides by "asbestos cement" slabs. Here one

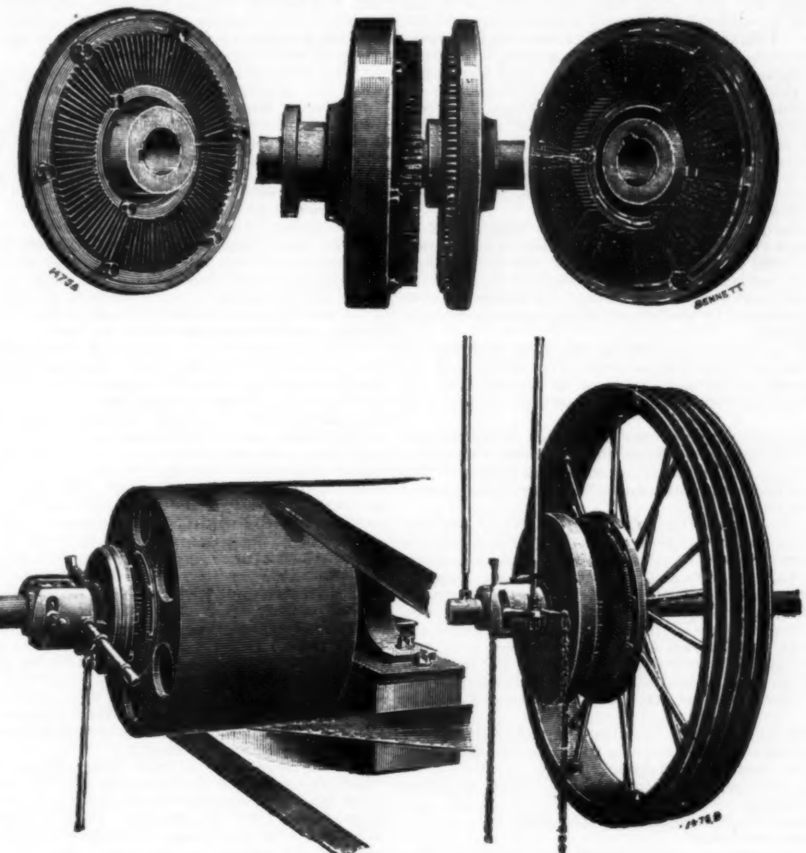
door after forty minutes at 1,000° C. bent, while another gave ample protection for one hour against a fire of 900° C. Similar doors are to be tried again, as there was apparently some flaw in the hanging of the faulty one. Their dimensions were 42 in. by 6 ft., and the thickness 1⅜ in.

The only door, in fact, that received the assessors' approval was one of remarkably simple construction, exhibited by the Berlin Fire Brigade. Its body was of double oak boards nailed at right angles to one another, well covered in with sheet iron, the ends of which overlapped and were nailed down. This door (like those of Messrs. Kuhlewein) was hung not *in* but *over* the opening, being some 6 in. larger than the latter in each direction. The fire to which it was subjected had a mean temperature of 1,000° C., and a duration of some seventy minutes. The door showed itself to be thoroughly fire and smoke proof, but on being examined the wood was found to be badly charred. A thin layer of some non-conductor would have probably remedied this failing, but as the firemen exhibiting had limited their contributions to "everyday" constructions, the use of such a material was not permissible.

The report of the assessors gives no information as to the cost of the exhibits, as the promoters wished to avoid anything that would tend to let a commercial feeling show itself in connection with the tests. This omission is, of course, in one sense an unfortunate one, as opinions as to the practical utility of the materials would be partially dependent on such information. For all this the experiments alone will have been invaluable to many, and even if the commercial element may have been rather too conscientiously avoided, the efforts of the promoters and the assessors should be fully appreciated. For once we have not had to deal with the tests of a tradesman advertising his wares, but with a *bona-fide* investigation in the interests of science alone.—*The Builder.*

SNYER'S ELASTIC COUPLING.

WE illustrate a form of clutch or coupling which is now being introduced by Messrs. Cowlishaw, Walker & Co., engineers, Etruria, Stoke-on-Trent. Essentially, says *Engineering*, the clutch consists of two disks, one of which is keyed to the driving shaft, and the other to the shaft or wheel to be driven. The face of one of these disks has fixed to it a number of toothed steel plates, while the opposing face of the other disk carries a series of brushes of flat steel wire, which, when the disks are pressed together, engage with the serrations on the other disk, forming a firm but elastic connection between the two. It is claimed that with these couplings there is no shock in starting even a high-speed machine. Thus, at the works of Messrs. Cockerill, Seraing, a couple of these clutches transmit 250 horse power each to the dynamos lighting the works, the speed being 200 revolutions per minute. The dynamos are started with the engines running at full speed, and for about 5 seconds slipping takes place, at the end of which the dynamo has reached its proper speed. In another case one of the clutches, running at 2,000 revolutions per minute, is used in the same way. We are informed that the clutch has been used for some years past on the Continent, where some 13,000 horse power are transmitted by its means.



SNYER'S ELASTIC COUPLING.

THE Snake Laboratory now being built under government supervision at Calcutta will be the first institution of its kind in the world. It is intended for the purpose of thoroughly investigating the properties of snake venom and testing cures for snake bites.

ABRASION OF WHEAT PRODUCTS.

By W. G. CLARK.

THE manner of handling wheat products, and the distance they travel in the course of manufacture, are two things very often regarded as of little importance in the art. Simple experiment, however, will readily show that abrasion is the inevitable result of travel, and that where the travel is long the abrasion becomes a factor working materially against good flour and a generally high order of results.

Abrasion is very much in evidence in the mills of to-day, producing quantities of impalpable dust that not only discolors the flour, but also makes it of uneven grain; whence follows a like unevenness of quality in the bread. In fact, a flour containing a large percentage of this dust has no life, no cellular formation to retain the carbonic acid gas given off by the yeast in fermenting, and little water-absorbing capacity; while a purely granular flour has all these qualities in a high degree.

When I say that one can reduce middlings to flour by simply rubbing them between the fingers, it is plain that when middlings are subjected to a prolonged rubbing against the sides and bottoms of long conveyors and spouts a considerable proportion of them will be reduced to something finer than flour. This stuff ought never to get into the flour, but once there it must be separated as completely as possible.

Flour that will pass through a 16 cloth is granular and fit for use, but here, in my mind, should be the limit. Yet, if we were to test the flour from almost any mills to-day, we should find a surprising quantity of so-called flour that would bolt through 17, 18, or even finer cloth. Now such stock is not fit to mingle in flour. It means poorer flour, poorer bread, and less bread to the barrel.

So I believe the most important steps in improved methods of milling will be in the way of reducing to a minimum the travel of stock. The "mill of the future" will have no conveyors except for wheat. Its machinery will be so arranged that the breaks will pass from one set of rolls to another, through scalpers and bolters, and each reduction drop to its place—finished material to flour packer, unfinished to roll or reel—without conveyors. I believe that 60 per cent. of the elevators will be done away, and be replaced by belt carriers, and that not more than one-fifth the present length of spouting will be employed.

Hungarian flour is selling at from $1 to $1.50 above the best American patents. Why? Because it is milled by a method which avoids abrasion of products, and which therefore insures an even and perfectly granular flour, yielding better bread and more to the barrel. I know this superiority is not in the grain, for the mills of Hungary have ground American wheat in short crop years, and still maintained quality and price.

We might as well acknowledge these facts—for they can be proved—and set about mending our methods accordingly.

I cannot speak too emphatically of the evil consequences of abrasion. I wonder that in these days of close competition and searching criticism on flour mill processes so vital a matter should be generally neglected. A miller wishes to make a simple change in his flow. To this end he adds an elevator, or long conveyor, a liberal proportion of spouting, and thinks it a good job so long as the stuff "gets there." The day is coming when no progressive miller will think of doing such a thing.

To return to the baker's point of view—bread made from flour containing the dust of abrasion will dry out quicker than that from a granular flour. This is because the dust is weak, or, rather, lifeless. Good bakers would tell us, furthermore, that this sort of flour yields a bread less sweet in the beginning, and souring much more quickly. The reason is, that in abraded flour the process of fermentation or decay is more rapid—the fine particles, indeed, have perhaps been partly decomposed before fermentation sets in. Bread of impure smell and taste, and poor keeping quality, is a natural result of abrasive milling.

The miller who gets his flour to the barrel by the shortest route will, other things being equal, make the best flour and the most money.—*Roller Mill.*

MANUFACTURE OF GLASS PIPES, TUBES, AND GUTTERS.

By P. SIEVERT, Dohlen, Saxony.

IN this process the pipe or tube is produced by rolling down molten glass in grooves or flutes and using a core to complete the formation of the pipe or tube. Molten glass is poured from a reservoir or hopper into the bite of two rollers. The rollers are placed horizontally, each being provided with grooves. A core of suitable dimensions is placed in the grooves. When the core is moved downward the molten glass follows the movement and forms a tube the dimensions of which are determined by those of the ring-shaped space between the contours of the grooves and the core. The speed at which the core is lowered is regulated according to the circumferential velocity of the rollers. When the downward movement of the core is completed, and the reserve ore is nearly emptied, the core is removed, when the tube may be subjected to the rolling process or may be annealed without rolling.

PRINTING-OUT PLATINUM PROCESS.

By C. C. HUTCHINS.

PREPARE the following stock solution:

	Oz.
I. Potassium chloro-platinite 60 grains, water...	1
II. Potassium oxalate 1 oz., water................	20
III. Solution II. 5 oz.; ammonio ferric oxalate 2 oz., glycerine........................	¼

Warm the potassium oxalate solution, add the ammonio ferric oxalate in crystals, dissolve, filter, and add the glycerine.

This solution must be kept from the light. A small stone bottle is a great thing to keep it in, then, if the stopper is kept in, it will suffer no harm should it be left exposed.

IV. Bromine water.

Put a few drops of pure bromine in a bottle, fill with water and shake. A small quantity only of the bromine dissolves, and when the solution is used it is only necessary to add more water.

The best paper is the River paper made for platinotype; the next best is plain Saxel. Have a medicine dropper in each of the bottles containing solutions I., III., and IV. Pin the paper flat upon a board. For the 8x10 sheets, measure into a small bottle 25 drops of I., 30 drops of III., and 1 to 5 drops of IV., according to the amount of contrast desired in the print. Pour the mixture upon the paper, with a tuft of cotton spread it about, squeeze the cotton dry to save all the solution, and then make the coating as even as possible, brush it every way with a broad camel's hair brush kept for this purpose and washed out immediately after use.

Dry the paper immediately after with the aid of heat. If the paper is bone dry it will not print, therefore leave it exposed to the air for a few minutes before printing. In the driest weather in winter I put behind the paper in the frame two sheets of dry wrapping paper, then one which has been wet and blotted off, then two more dry sheets. Print in direct sunlight to the exact density required in the finished picture.

After printing, the prints are washed for a few minutes in two or three changes of acid water (muriatic acid one part, water eighty), then for ten minutes more wash in plain water, and they are finished.

Negatives for platinum prints should be clear and of good strength. Thin flat negatives give similar prints. —*American Amateur Photographer.*

THE LIGHT OF THE ELECTRIC ARC.

AT a recent meeting of the International Society of Electricians, M. Violle described the experiments which he had been making on the electric arc. This experimenter has found that the light intensity of the positive carbon remains sensibly constant when the power supplied is varied in the proportion of 1 to 60. He has employed two methods of measurement: that of the spectrophotometer, the accuracy of which is really much greater than is usually stated to be the case; and a second method due to Arago, employing interference fringes. M. Violle exhibited a number of photographs of arcs of different candle power, in order to show the constancy of the intensity of the positive carbon. By measuring the opacity of the negative plates, these photographs could be used as a gauge of the intensity. M. Violle recalled that this phenomenon had already been investigated by Rosetti, as well as by Capt. Abney and Silvanus Thompson; and every one had attributed it to vaporization of the carbon. This opinion was perfectly justified, for the deposit on the negative carbon has the appearance of having been condensed from vapor, and M. Violle had actually been able to produce crystals on this part. A photograph of an arc produced between carbons of purified retort carbon was next shown, and this exhibited a very curious appearance. Despretz had also observed that the phenomenon was due to volatilization, but that there was fusion or more or less softening of the carbon; he had also attributed the deposit of carbon, which is formed in the arc, to the condensation of vapor of carbon, but he was unable to elucidate the question, because he used impure carbons. M. Blondel has recently recognized that impurities in the carbon have not, in practice, any sensible effect on the intensity, which remains constant with carbons of very different quality. The intensity of the arc, he thought, was therefore a constant, and it might be utilized as such. M. Violle stated, in conclusion, that the temperature of

3,500° C., which is given for the arc, ought to be considered as a provisional value, although the true temperature is probably but little different from this figure.

A CONDENSED ARCHITECTURAL HISTORY OF THE WORLD'S COLUMBIAN EXPOSITION.*

By D. H. BURNHAM, Chief of Construction.

I DO not know who first advocated the holding of a World's Fair on the four hundredth anniversary of the discovery of America by Columbus, but by the summer of 1889, New York, Washington, St. Louis, and Chicago had organizations at work, each in the interests of its city. The one in Chicago started to raise money by subscription. It sent a well-known railway manager, Mr. E. T. Jeffrey, and an engineer, Mr. Chanute, to examine and report regarding the French Universal Exposition then being held in Paris. It also elected a committee to report on sites, and this committee invited the writer to consult with them, which he did during the fall of 1889 and the winter following. Very little was accomplished, as the chief interest then centered in the contest before Congress by the cities interested in securing from the government the location of the Exposition; but on April 9, 1890, the State of Illinois licensed the corporation since known as the "World's Columbian Exposition," and on April 25 of the same year the national Congress passed an act naming Chicago as the one within whose limits the Fair was to be held.

The act of Congress provided for a national body, to be known as the "World's Columbian Commission," to which was intrusted the custody and care of exhibits and all communications with foreigners and exhibitors, and it also provided for the local corporation I have mentioned, to which was intrusted the designing and building of the Exposition and the custody and care of it to the end of the Fair.

The national commission organized and elected a president, a secretary, and a director-general. The Illinois corporation also organized and elected a president and secretary and appointed various committees; among them that of grounds and buildings.

For the rest of the spring and during the first two summer months much time was wasted over the question of a site in Chicago; various committees from the corporation, the national commission, the city authorities, and the Illinois Central Railroad, being engaged in the discussions, with little hope of a settlement. On August 20, however, the first real step in the right direction was taken, and the local corporation then retained as consulting landscape architects the firm of F. L. Olmsted & Co., of Brookline, Mass. On September 2, thirteen days afterward, Mr. A. Gottlieb was appointed consulting engineer, and Messrs. Burnham & Root consulting architects. In the following October, Messrs. Burnham & Root resigned, Mr. Root then being elected consulting architect, and the writer being made chief of construction, all at one meeting.

These officers reported to the grounds and building committee, which had "jurisdiction in all matters pertaining to grounds, leases, engineering, designs, plans, construction of buildings and works, maintenance of buildings and grounds; organization of guards, police, detective and fire departments, gas, electric lights, water supply, medical service, application for space, telegraphy, insurance, etc." The chief of construction was made the executive officer of the committee and the consulting architect, landscape architects and engineers were ordered to report to him.

Early in the fall of 1890 the two controlling bodies selected Jackson Park and the down town lake front as what was called the "dual site," it being stipulated that the Fine Arts building, the Liberal Arts building, and the Music Hall should be kept "down town," and all other buildings be in Jackson Park. This decision was reached after a careful report by Olmsted & Co. of all the sites tendered, and upon the advice of all the members of the consulting board.

The South Park commission leased Jackson Park and Midway Plaisance to the World's Columbian Exposition and it was agreed between the parties:

1. That the grounds should be cleared of all buildings and turned back to the commission on or before a certain date.

2. That improvements made by the Exposition were to be as far as possible in the direction of the permanent improvement of the park.

The original designs of the South Park were made by Mr. Frederick Law Olmsted and Mr. Calvert Vaux, about 1870. When, therefore, we took up the study of grounds for the purpose of devising a plan for the Exposition, Mr. Olmsted's familiarity with the site and his superior knowledge of landscape effects caused us to be guided by him in general features. Mr. Codman, his partner, was a man well trained in all matters relating to the setting and surroundings of buildings. His training, both here and in France, his extensive travel, knowledge and natural aptitude, fitted him to be both adviser and executant in this important work.

The general scheme of land and water was suggested by Mr. Codman. The arrangement of the terraces, bridges, and landings was suggested by Mr. Codman after the architectural board had adopted a style for the Grand Court. The size and number of the Exposition buildings proper was determined from the schedule made by the classification committee, the order of the chairman of the building committee being to plan for structures covering about one-third more area than those in Paris in 1889. The shape and disposition of the buildings was determined by Mr. Root and myself, the engineer, Mr. Gottlieb, being, of course, consulted as well.

While I mention the particular part in which each led, it is true that all of us consulted together on questions that arose, and nothing was finally determined upon which did not have the approval of all. Several tentative plans were rudely drawn on the cross-sectioned lithographed maps of Jackson Park, and a final one early in December, 1890, which was then adopted by the national commission and the Illinois corporation as the plan of the Exposition, though it only dealt with buildings immediately around the Grand Court, the horticultural, fisheries, and the government space. This plan made no provision for State, Foreign, or Woman's buildings, for the Midway Plaisance, or the structures south of Machinery Hall and Agricultural building. It was a suggestion, and it was not intended by us to present more than the mere central idea for the parts of the scheme then treated of. There was nothing original in it, except the introduction of the canal, the lagoons and Wooded Island, the Grand Court being the same arrangement as at Paris, with a water basin in the center and a dome at one end, in front of which was to be the great fountain. The plan was the work of us all. It was not due to an inspiration, but it was thought out logically, step by step, keeping in view the immediate purposes of the Exposition and the final treatment of the ground as a public park.

It was a crude outline, without suggestion of architectural treatment or style. In fact, nothing was done or said as to the architecture proper, except idly and in a desultory way. Mr. Root at that time leaning to variety in style and color for the buildings of the Fair. On December 1, 1890, the status was as follows:

The Exposition was to be built on two sites, seven miles apart, and a sketch plan for part of one of them had been officially adopted. It was necessary to take charge of nearly 700 acres of land, the larger part of which was swampy, to design and build the Exposition and place the exhibits in two years and five months.

For this purpose it was necessary to quickly organize a competent force of architects, sculptors, painters, engineers, police, firemen, business men, and clerks. Every moment was precious. It was out of the question for the firm of Burnham & Root to think of designing all or any part of the buildings, because of the relations its members had already assumed toward the enterprise. I therefore drew up the following memorial to the grounds and buildings committee, which my *confreres* signed at my request. It was sent December 9, 1890, to the committee on grounds and buildings.

"Preliminary work in locating buildings, in determining their general areas, and in other elementary directions necessary to proper progress in the design and erection of the structures of the Columbian Exposition has now reached a point where it becomes necessary to determine a method by which designs for these buildings shall be obtained.

"We recognize that your action in the matter will be of great importance, not only in its direct effect upon the artistic and commercial success of the Exposition, but scarcely less upon the aspect presented by America to the world, and also as a precedent for future procedure in the country by the government, by corporations, and individuals.

"In our advisory capacity we wish to recommend such action to you as will be productive of the best results, and will at the same time be in accord with the expressed sentiments of the architectural societies of America.

"The following suggestions relate only to the central group of buildings in Jackson Park, it being the intention from time to time to designate other architects for the various important structures that are to be erected in addition thereto.

"That these buildings should be in their designs, relationships and arrangement of the highest possible architectural merit is of importance scarcely less great than the variety, richness, and comprehensiveness of the various displays within them. Such success is not so much dependent upon the expenditure of money as upon the expenditure of thought, knowledge, and enthusiasm by men known to be in every way endowed with these qualifications; and the results achieved by them will be the measure by which America, and especially Chicago, must expect to be judged by the world.

"Several methods of procedure suggest themselves:

"1. The selection of one man to whom the designing of the entire work should be intrusted.

"2. Competition made free to the whole architectural profession.

"3. Competition among a selected few.

"4. Direct selection.

"The first method would possess some advantage in the coherent and logical result which would be obtained. But the objections are, that time for the preparation of designs is so short that no one man could hope to do the subject justice, even were he broad enough to avoid, in work of such varied and colossal character, monotonous repetition of ideas. And again, such a method would invoke criticism, just or unjust, and would certainly debar the enterprise from the friendly co-operation of diversity of talent, which can be secured only by bringing together the best architectural minds of the country.

"2. The second method named has been employed in France and other European countries with success, and would probably result in the production of a certain number of plans possessing more or less merit and novelty. But in such a competition much time, even now most valuable, would be wasted, and the result would be a mass of irrelevant and almost irreconcilable material which would demand great and extended labor to bring into coherence. It is greatly to be feared that from such a heterogeneous competition the best men of the profession would refrain, not only because the uncertainties involved in it are too great and their time too valuable, but because the societies to which they almost universally belong have so strongly pronounced on its futility.

"3. A limited and fair competition would present fewer embarrassments; but even in this case the question of time is presented, and it is most unlikely that any result derived through this means, coming as it would from necessarily partial acquaintance with the subject, and hasty, ill-considered presentation of it, could be satisfactory, and the selection of an individual would be open to the same objections made above as to a single designer. Far better than any of the methods seems to be the last.

"4. This is to select a certain number of architects, choosing each man for such work as would be most nearly parallel with his best achievements. These architects to meet in conference, become masters of all the elements to be solved, and agree upon some general scheme of procedure.

"The preliminary studies resulting from this to be compared and freely discussed in a subsequent conference, and, with the assistance of such suggestions as your advisers may make, be brought into a harmonious whole.

"The honor conferred upon those so selected would create in their minds a disposition to place the artistic quality of their work in advance of the mere question of emoluments; while the emulation begotten in a rivalry so dignified and friendly could not fail to be productive of a result which would stand before the world as the best fruit of American civilization.

"*Signed*, D. H. BURNHAM, *Chief of Construction.*
JOHN W. ROOT, *Consulting Architect.*
F. L. OLMSTED & CO., *Consulting Landscape Architects.*
A. GOTTLIEB, *Chief Engineer.*"

This paper precipitated a heated debate. There were strong advocates for competition, and the committee was solemnly warned by some of its members against choosing by any other method; but finally, through a narrow majority, the recommendation was adopted. The committee then placed in my hands the selection of five architects to design the buildings around the Great Court. The rude plan I have spoken of showed two buildings where the Electrical and Mines now are, but their long axis ran east and west, instead of north and south, as at present. This arrangement would have left five buildings fronting on the Great Court, instead of six, as is now the case. I selected five men, or firms, and the committee promptly confirmed them. I then sent to each of them the following letter:

"The inclosed recommendation was approved last night by the Board of Directors of the World's Columbian Exposition, and in the same resolution they empowered the Grounds and Building Committee to secure the services of five architects to design the main group of buildings at Jackson Park.

"The committee authorize me to confer with the following gentlemen, namely: Richard M. Hunt, of New York, McKim, Mead & White, of New York, George B. Post, of New York, Peabody & Stearns, of Boston, Van Brunt & Howe, of Kansas City, with a view to your employment.

"It is intended to place the problem in your hands as to the artistic aspects only:

"1. Of the group as a whole.

"2. Of the separate buildings.

"The committee are disposed to leave the method of designing to the five architects, and you may determine among yourselves whether to make a joint design of the whole as one, or each to take up separate parts to be modified to meet such views as shall be expressed in your conferences from time to time.

"This bureau will be expected to supply you with all data about materials, sizes, general disposition and cost of buildings, and it is also to have charge of the constructional features, and finally of the execution of the entire work; but with the understanding that the artistic parts are to be carried out with your approval, and that you are from time to time to visit the work either in a body or separately as may be determined wise. Our consulting architect, Mr. Root, would act as your interpreter when you are absent, without imparting into the work any of his own feelings.

"I realize the hesitancy you may feel in assuming responsibility for design when you do not fully control the execution of it. The committee feel, however, that strict economy of the two essentials, time and money, will be best subserved by keeping the actual control of the work in the hands of one man and his bureau; and I can assure you that your intents and purposes of design, once agreed upon by the committee, shall be carried out as you wish, and that they shall not be altered or meddled with, and when exigencies arise, making any important change necessary, you shall be consulted and have the matter in charge the same as in original design.

"I will be pleased to hear from you by wire, if you think favorably of this proposition. I shall be here until Monday evening, and unless detained shall be in New York City Wednesday next, stopping at the Windsor. As in a personal interview it will be possible to make matters much more plain, I hope to find a note saying that I may have the honor of seeing you. Those who accept should make a preliminary visit here together as soon as possible.

"Yours very truly,
D. H. BURNHAM, *Chief of Construction.*"

This brought the time up to within a week of Christmas, 1890.

On December 22 I met in New York Messrs. Hunt, Post, Peabody and Mead, and secured an agreement from them, and by telegram from Mr. Van Brunt, that they would visit Chicago together on the 10th of January following. On my return to Chicago, the Grounds and Buildings Committee authorized me to select five architects from Chicago to design the other great structures of the Exposition. The men nominated and promptly confirmed were Burling & Whitehouse, Jenney & Mundie, Henry Ives Cobb, S. S. Beman and Adler & Sullivan. I called on each of them the next morning and obtained acceptance.

The architects met in the office of Burnham & Root on Saturday, January 10, 1891, there being present:

Consulting Architects Olmsted & Codman
Consulting Engineer Gottlieb

Richard M. Hunt	New York
Robert S. Peabody	Boston
Geo. B. Post	New York
Wm. R. Mead	New York
Henry Van Brunt	Kansas City
Dankmar Adler	Chicago
Louis H. Sullivan	Chicago
F. M. Whitehouse	Chicago
S. S. Beman	Chicago
Henry Ives Cobb	Chicago
W. L. B. Jenney	Chicago

and myself. Mr. Root was absent from the city, but arrived during the afternoon, in time to meet those present and be introduced to those he was not acquainted with. An organization was effected by the selection of Mr. Hunt as chairman and of Mr. Sullivan as secretary, and an adjournment was taken until Monday. That night a banquet was given by the

* From a paper read before the World's Congress of Architects, Chicago, August, 1893. From the *American Architect.*

Grounds and Buildings Committee to the Architectural Board at University Club.

On Monday the board met, but Mr. Root was missing. At noon word came of his illness, which terminated fatally on Thursday afternoon. Mr. Root possessed a mind remarkable for its artistic insight, quickness and clearness of apprehension, and deep sympathy with everything of value about him. Though filled to running over with his own suggestive thoughts, he never failed to grasp another's, and it was his everyday custom to co-ordinate the elements of discussions with a rapidity and finish that seemed marvelous. His very visions were as real to him as the actual objects of life are to the eyes of other men. He saw comprehensively and exactly, both through his natural eyes and those of his spirit, and his power of expression to the ears, the eyes or the hearts of others kept pace with his own vivid impressions.

I cannot, of course, believe that the architecture of the Exposition would have been better had he lived, but it certainly would have been modified and stamped with something of his great individuality. My own loss I cannot speak of. Our relations had been intimate, and even fond, from the week when first we met. We had lived together for eighteen years without a written agreement or a quick word between us. When he died, I remained with the Exposition only in deference to the judgment and wishes of my friends among the directors.

The discussions of the board extended through the week after the death of Mr. Root, the plan being modified by important changes, and at the end of the meeting I apportioned the work among the men as follows:

F. L. Olmsted & Co. . . Landscape Architects.
Richard M. Hunt. . . . . . Administration.
Peabody & Stearns . . . . . Machinery.
McKim, Mead & White . Agricultural.
Geo. B. Post . . . . Manufactures and Liberal Arts.
Van Brunt & Howe. . . . Electricity.
S. S. Beman. . . . . Mines and Mining.
Adler & Sullivan . . . . . Transportation.
Henry Ives Cobb. . . . . . Fisheries.
Burling & Whitehouse. . Venetian Village.
W. L. B. Jenney. . . . . . . Horticultural.

This was only twenty-one months before the date set by Congress for the dedication of the completed grounds and buildings of the Exposition. The work done by the board at its January meeting was:

1. Confirmation of general scheme.
2. Settling exact sizes of court and canal.
3. Settling exact size and location of the following buildings: Agricultural, Manufactures, Electrical, Mines, Fisheries, Horticultural, Administration, Machinery, Transportation, Venetian Village.
4. The height of cornice around the main court.
5. The approximate height of terraces above datum.

On February 20 the Board met again, this time Mr. McKim coming instead of Mr. Mead, and the New York members being accompanied by Mr. Augustus St. Gaudens, the sculptor, who was retained as adviser. They then brought with them the rough sketches, each of his own building, and the landscape architects brought a full-scale plan of the grounds of Jackson Park, extending from north of the Fisheries building to south of Machinery Hall.

The following week was one of interest to all the conferrees. Mr Hunt presided in the meetings. Each designer displayed his sketches upon the wall, explaining the purpose and intent of his work, and submitting to the kindly critiisms of all the others. The Grounds and Buildings Committee spent a day in the room, where every design was carefully explained to them by its author; afterward the proper officers of the National Commission also met the architects, when the same process was gone through again. The whole work was then formally passed upon and adopted by the World's Columbian Exposition and the World's Columbian Commission, and this memorable meeting came to an end late in February, 1891. One of the most eminent artists who had been present at all of the meetings, on parting, remarked: "This has been the most important artistic moment of my life." The sentiment so expressed was echoed by every one present. Then, for the first time, one could commence to form an idea of the architecture which we are now familiar with. The strongest enthusiasm prevailed, and a high sense of the importance of the work dawned upon us.

During January, when the main plan of the work had been approved, the chief engineer let a contract for the excavation of the basin, lagoons, and inlets, and while the architects were here in February the work commenced.

After the adjournment, it was determined by the Grounds and Building Committee to select an architect for the Woman's building by competition, to be confined strictly to women. Twelve sets of sketches were submitted for the day appointed, and three prizes were given: The first to Miss Sophia G. Hayden, of Boston; the second to Miss Lois Howe, of Boston; and the third to Miss Laura Hayes, of Chicago. Miss Hayden was at once employed as the architect of the building, and since then has made the designs and overlooked the construction of the building. Examination of the facts show that this woman had no help whatever. The design was made by herself in her own home.

This brings the history of the enterprise down to about March 1, 1891. At this point, for the first time, the chief of construction was enabled to form an estimate of the work to be done. Roughly speaking, it consisted of reclaiming nearly seven hundred acres of ground—only a small portion of which was improved, the remainder being in a state of nature, and covered with water and wild oak ridges—and in twenty months converting it into a site suitable in substance and decoration for an exposition of the industries and the entertainment of representatives of all the nations of the world. On its stately terraces a dozen palaces were to be built—all of great extent and highest architectural importance—these to be supplemented by two hundred other structures, some of which were to be almost the size of the Exposition buildings themselves; great canals, basins, lagoons, and islands were to be formed; extensive docks, bridges, and towers to be constructed. The standard of the entire work was to be kept up to a degree of excellence which should place it upon a level with the monuments of other ages. The opportunity for gaining honorable distinction, however, made the duty of choosing men for the force comparatively easy, and in a very short time after the plans were finally adopted, the following were on the field of action, working with one object, the welfare of the great enterprise:

Charles B. Atwood. . . Designer in chief.
William Pretyman. . . Director of color.
E. G. Nourse. . . . . General engineer.
Frederick Sargent. . Electrical engineer.
J. C. Slocum . . . . . . Mechanical engineer.
Wm. S. MacHarg. . . . Sanitary and water engineer.
John W. Alvord. . . . . Engineer of grades and surveys.
Earnest R. Graham. . Assistant chief of construction.
Rudolph Ulrich. . . . . . Landscape superintendent.
Dion Geraldine . . . . . General superintendent.

Later the following changes occurred: Mr. Frederick Sargent assumed entire charge of all mechanical plants, Mr. Slocum going out, and Mr. R. H. Pierce becoming electrical engineer, and in March of this year Mr. Sargent withdrew, leaving Mr. Charles F. Foster in charge as mechanical engineer, where he still remains. Mr. Gottlieb, the chief engineer, withdrew in the summer of 1891 and Mr. Edward C. Shankland took his place. Mr. W. H. Holcomb has since joined the force as general manager of transportation. Mr. Pretyman resigned in May, 1892, and Mr. Frank D. Millet took his place. Col. Edmund Rice, of the United States army, assumed control of the guard in May, 1892. Marshal Edward Murphy took charge of the entire fire department in December, 1892, taking the place of Mr. A. C. Speed, who had been in charge until then.

Mr. C. D. Arnold was made official photographer. Dr. John E. Owen was made medical director. Mr. Atwood came out to join me in my private practice in the spring of 1891, but the needs of the Fair were so great that he assumed the place of designer-in-chief instead.

The Venetian village being abandoned, and it having been concluded to place the Music and Fine Arts buildings in Jackson instead of in the down-town park, Mr. Whitehouse was urged to design the Fine Art palace, but severe illness at the time prevented him from doing it. This building then went to Mr. Atwood. When the Venetian village on the end of the pier in front of the Grand Court was abandoned, Mr. St. Gaudens suggested the thirteen columns as shown on the earlier plans of the work; but this being finally deemed to be inadequate, the Music Hall, Peristyle, and Casino, as one composition, was intrusted to Mr. Atwood, and then Mr. Whitehouse also took up the very important work of designing the Festival Hall.

The following buildings have been erected in Jackson Park and Midway Plaisance. Those built by the Exposition are as follows:

Administration building.
Machinery hall and boiler house.
Pumping station.
South colonnade.
Agricultural building.
Forestry building.
Dairy building.
Freight houses.
Convent of La Rabida.
Stock ring.
Company's shops.
Company's barn.
Sewage cleansing works.
Landscape propagating house.
Tank house.
Sawmill.
Peristyle, Music Hall, and Casino.
Manufactures and Liberal Arts.
Electricity building.
Mines and Mining building.
Transportation and Annex.
Terminal station.
Grounds and Buildings, headquarters.
Photographic building.
Horticultural building.
Horticultural greenhouses.
Woman's building.
Fire and police houses.
Fisheries building.
Mechanical offices.
Art building.
City police stations, Woodlawn and Hyde Park.
Art Institute (down town).
Leather building.
Silos.
Model building.
Stock barn.
Custom house.
Choral Music building.
Entrances.
Music stands.
Perron and sheds.
Sheds for empty cases.
Children's building.
Public comfort.

These buildings aggregate 6,500,000 square ft.

The following States have built headquarters:

Illinois, California, Colorado, Washington, South Dakota, Nebraska, North Dakota, Kansas, Texas, Utah, Iowa, Montana, Kentucky, Florida, Arkansas, Minnesota, Missouri, Louisiana, West Virginia, Pennsylvania, New York, Maryland, Delaware, New Jersey, Rhode Island, Massachusetts, Vermont, Connecticut, New Hampshire, Maine.

The State buildings occupy over 40,000 sq. ft.

The following foreign governments have built:

Great Britain, Canada, Russia, Germany, Ceylon, France, Turkey, Hayti, Norway, Sweden, Brazil, Nicaragua, Colombia, Guatemala, Costa Rica, Japan, Venezuela, New South Wales, Spain, and East India, covering an area of over 300,000 sq. ft.

The following concessionaires have built:

Bedouin encampment, Lapland village, ostrich farm, Dahomey village, Brazilian concert hall, Chinese village and theater, Algerian and Tunisian bazar, Japanese bazar, Dutch settlement, German village, street in Cairo, Ferris wheel, volcano of Kilauea, captive balloon, East Indian village, American Indian village, Hungarian cafe, Austrian village, Persian concession, French cider press, ice railway, Eiffel tower, Natatorium and Vienna bakery, Irish village, Irish industries village, United States Submarine Diving Company, log cabin, reproduction of St. Peter's, Moorish Palace, Libby Glass Company, Turkish village, Hagenbeck's animal show, panorama of Bernese Alps, Venice-Murano Glass Company, Merck drug exhibit, Cafe de Paris, electric scenic theater, Adams Express Company, International Dress and Costume Company, Workingman's Home, Diamond Match Company, clam bake, Walter Lowney chocolates, Walter Baker cocoa, Van Houten cocoa, Japanese tea house, Great White Horse Inn, *Puck* building, White Star Steamship Company.

They will aggregate over 1,100,000 sq. ft. The total grand area of the buildings in the Fair is something less than 200 acres.

The artists engaged on the decorations were:

G. J. Melchers,	G. W. Maynard,
W. McEwen,	L. H Sullivan,
E. H. Blashfield,	W. L. Dodge,
C. S. Reinhart,	D. M. Armstrong,
E. E. Simmons,	Turner,
R. Reid,	J. A. Weir,
W. Shirlaw,	C. C. Coleman,
K. Cox,	M. J. Cassatt,
J. C. Beckwith,	C. Wheeler,
F. D. Millet,	L. J. Millet and others.
L. C. Earle,	
E. E. Garnsey,	

The sculptors were:

D. C. French,	R. W. Bock,
E. C. Potter,	Bock,
L. G. Mead,	Pratt,
P. Martiny,	T. Baur,
M. A. Waagen,	J. A. Blankingship,
K. Bitter,	H. A McNeill,
C. Rohl-Smith,	E. Kemeys,
A. P. Proctor,	R. Kraus,
L. Taft,	J. Gelert,
E. Yandell,	O. L. Warner,
A. L. Rideout,	A. St Gaudens,
J. J. Boyle,	F. McMonnies.

I cannot, in this paper, describe the works or tell you the amounts of material which have gone into construction. This must be done in an official report, which will take many months to prepare.

I can, however, tell you how, during the storms of summer, the frosts of winter, all day, all night, week in and week out, for two years, the little band of American boys ran the race for victory with Father Time, and won it. Without looking for or expecting compensation at all equal to the services they have rendered, without jealousy, with ready willingness, these men have been ever at the front, emulating each other in the amount and quality of the services rendered.

Though I cannot now pick individuals to be praised, I can congratulate all on the glory they have won through constancy and self-sacrifice such as no other country ever gained from her sons in time of peace. They have shown what, to me, is the greatest heroism, that of forbearance and constant helpfulness. I am most proud of having been associated with them.

THE COLUMBIAN EXPOSITION—THE GERMAN WINE BUILDING.

STANDING in the south court of the Horticultural building is a structure covering 2,000 square meters, which is given over wholly to an exhibit of German wines, but which is unobserved by the great body of Exposition visitors, yet this little building is one of the gems of the Fair. It is built in the form of a cloister cellar, and, even with the exhibitive features introduced into its architectural composition, it is still as retired and quiet in general feeling as the cloisters which it represents. The interior space is occupied with tables and stands of wine in bottles, the combined exhibition of 289 growers and dealers of the German empire. The arrangement of the bottles is effective, because very simple. There is no effort, as there is in some other exhibits, to obscure the monotony of the display by mere decorative or striking designs. One or two bottles of the different brands made by the various exhibitors are shown upon circular racks. There is no wine exhibit in the Exposition, it is said, which contains so much variety in actual brands and number of exhibitors as this "Deutsche Wein Austerlung."

To the general public, however, the merit of this unique building lies in the remarkable panoramas which lie beyond its eastern and southern walls. Upon these sides the building is opened between pillars, and some of the most striking of the German wine regions are thrown upon canvases beyond. One looks out, as from a porch, upon landscapes of remarkable picturesqueness, and the effect is greatly heightened by plantations of grapevines in the foreground. These grapevines are the actual plants brought from the neighborhoods represented on the canvas, and set in earth as they customarily grow. Of course, the vines are not living, but they have been so dexterously clothed with artificial leaves and fruit that they represent the growing and bearing vine almost perfectly. As each of the panoramas represents a distinct wine district, so the vines in each foreground show the exact method of training in those districts; and the artificial fruits represent the varieties grown there. There are probably no panoramas in the Exposition which are more perfect in their way than these in the German Wine building.

The first panorama, as one enters the building from the main entrance at the north, is a view of the Rhine from Niederwald. The canvas is 24 ft. high by 36 ft. long, and it represents a radius of 18 miles. The painting is by Herwarth and Rummelspacher, Berlin. The canvas shows the Rhine at the junction of the Nahe, with Bingen and Rudesheim drawn in detail. At the left is the famous castle of Rheinstein, and in an island in the river is the Mouse Tower, both conspicuous objects to all tourists of the Rhine. The canvas is remarkable for its panoramic features. The vines which stand in the foreground of this remarkable landscape

stand about 3 by 2 ft. asunder, and are trained to single light stakes some 5 ft. high. Two or three arms arise from near the root and are tied straight up along the stakes. The grape chiefly grown here is the white Riesling. The second panorama is the same size as the first and is made by the same artists. It represents three widely separated regions, although the landscapes have been selected with reference to effective combination upon the same canvas. At either side are views from the Mosel—Trarbach and Traben at the left and Trier at the right—and between them is the vale of Neustadt an der Haardt. At Trarbach and Traben the vines are trained to stakes, five or six canes arising from the surface and disposed in loops upon the stakes, a common method in European vineyards. At this place the Riesling is the chief wine grape. At Neustadt the vines are trained on low trellises of one or two wires, the system being very like that known in Western New York as the high renewal. Two main arms or heads arise from near the surface of the ground, from each of which two or three canes are carried out upon the wires. At this point the chief wine grapes are Riesling, Sylvaner, Traminer, and Portugieser. The Fleisch Trauben, which is our Black Hamburg, is grown, but not for wine.

The third panorama, painted by Von Freudemann, Richter, and Lefensdorf, Berlin, shows the Neckarthal—or Neckar Valley—from Esslingen to Cannstadt. This is a part of the Alsace-Lorraine region, noted for its mild wines. Here the vines are grown to three main arms, trained to as many stakes, which stand about 2 ft. apart, with a space of 2½ ft. between the rows. The arms are bent inward at the top in hoop fashion. The wine grapes of this region are the Riesling, Sylvaner, Limberger, and Trollinger. The last is said to be identical with Black Hamburg, but it is here used for wine making. Rappoltsweiler, in Alsace, is the subject of the next canvas, by the same artists. It is one of the boldest of the lot, although small, for the great crag and castle of Rappolstein stand in the foreground. In the distance can be seen Strassburg and the cathedral. Chasselas, Guteder, Riesling, Ortlieber, and Black Burgunder are the wine grapes of this particular region. The vines are trained to stakes 6 or 7 ft. high, the arms being three, with the tops recurved inward like a hoop. The fifth and last panorama is a scene in Baden, at Mullheim. Here the vines, trained to two or three arms, are tied nearly straight up to short stakes. At this place the leading wine varieties are Krachgutedel, Riesling, Sylvaner, and Black Burgunder. Aside from these striking panoramas, the building contains large fresco maps of the wine regions of the Rhine and Mosel and of Alsace-Lorraine.

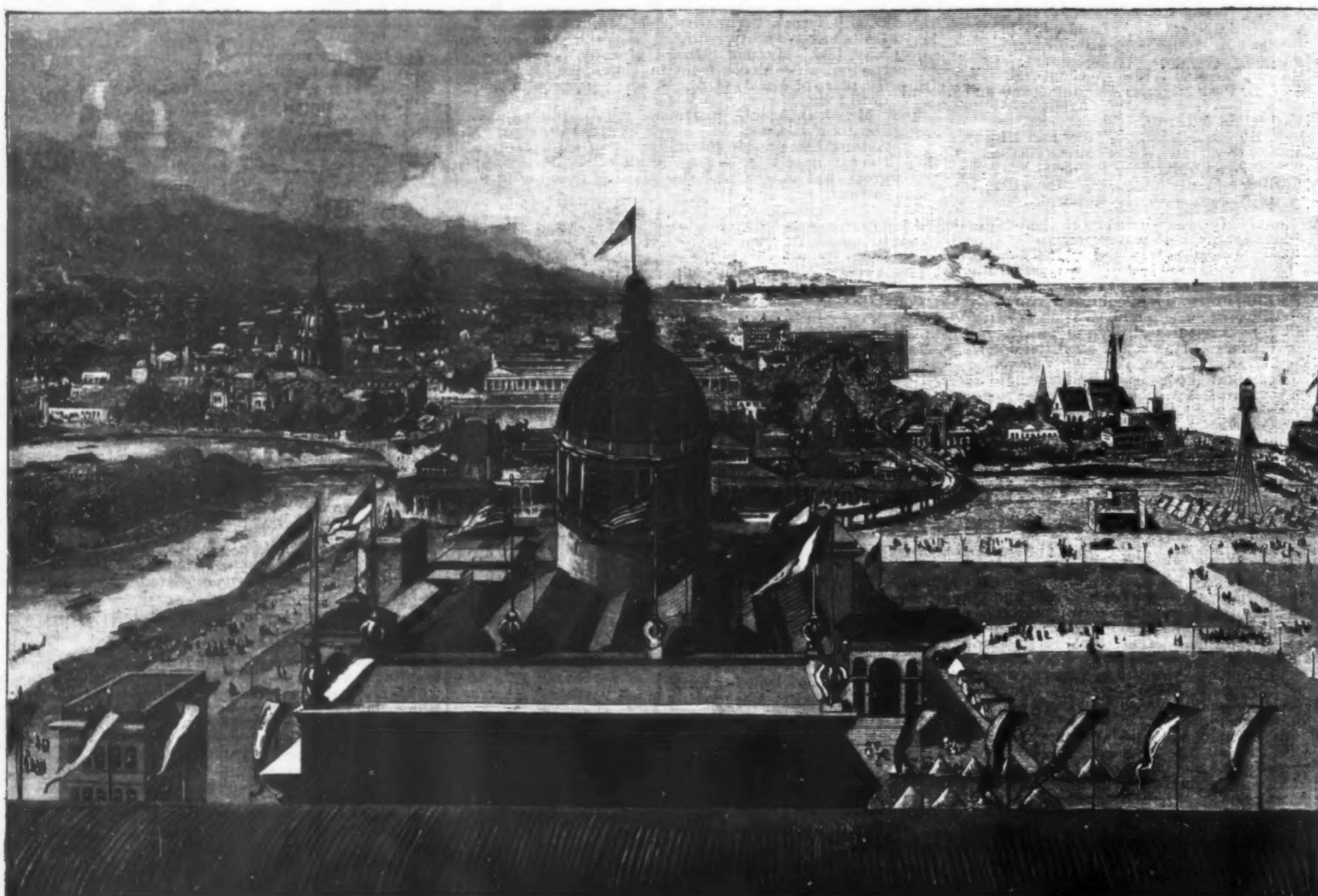
The expenses attending the construction of the building and exhibit were divided between exhibitors and the German government, the latter contributing 25,000 marks. The general charge of the German wine interest at the Exposition is in the hands of Commissioner H. W. Dahlen, a resident of Geisenheim, on the Rhine. The exhibit is one of the most unique and valuable upon the Fair grounds, and it is a pity that so few people see it. The panoramas may be likened to inclosed porches. The observer stands in the window and looks outward. The canvas incloses the far side of the porch, while the planted vines occupy the floor. The roof, which is obscured by projecting eaves of vines, is glass, and all the changing shadows of the sky are reflected upon the canvas, giving it the varying expressions of life.—*L. H. Bailey, in Garden and Forest.*

THE WORLD'S COLUMBIAN EXPOSITION—A BIRD'S EYE VIEW.

THE Paris Exposition of 1889 had the Eiffel Tower, and thereby achieved a double success: First an increase of the lighting effects during night time, the beams of light emitted from the top of the tower appearing to belong to those high regions in which, ordinarily, but the stars perform their functions; and secondly, during the day time, the extended view one could enjoy from the highest story of the tower. The World's Columbian Exposition, as will be universally known, does not possess an Eiffel Tower, the gigantic wheel represented in our last number being intended as a substitute therefor. This wheel, however, is scarcely one-third the height of the Eiffel Tower, besides disfiguring the whole grounds of the Midway Plaisance by its ungraceful shape. Illuminating effects such as could be produced on the Eiffel Tower are, therefore, impossible at the World's Columbian Exposition, but the latter affords opportunities of distant views which, owing to the favorable situation of the Fair grounds, are just as remarkable in their kind as those to be observed from the Eiffel Tower. We are even inclined to give the preference, in several respects, to the view to be seen from the top platform of the large Exposition building (the Manufactures building) over the panorama to be witnessed from the upper story of the Eiffel Tower. At the latter place the spectator can avail himself but of a comparatively small space, whereby the number of landscape views which are placed before his eyes is somewhat reduced. On the top platform of the principal building of the Chicago Exposition the conditions of space are much more favorable. The platform is surrounded on its four sides by a broad promenade. About half an hour is required to walk all around the platform, and in this way a profusion of the most magnificent landscape and architectural views are displayed. The ascent to the platform is made by means of an electric elevator. Many of those who see themselves lifted to a vertiginous height in a few seconds are involuntarily seized with a feeling of uneasiness when they see the colossal group of the Exposition far below, looking like delicate toys set up by children; this feeling, however, vanishes as soon as the platform is reached. The gaze of the spectator then first dwells on the projecting roof, so that fits of vertigo are impossible even with persons who are subject to such fits. The projection of the roof, however, is not considerable enough to notably obstruct the view of the neighboring landscape. Nearly all the Exposition buildings present themselves in their entire majestic splendor; the little defects which below offended our artistic taste here recede to the background. The impression of the surrounding landscape is heightened by the many water surfaces, especially by the sea-like sheet of the green Lake Michigan, the opposite shore of which is but partly visible as white calcareous rocks. On the west side of the Exposition grounds are situated the partly artificial water channels and ponds which surround the beautiful Wooded Island.

The draughtsman has selected, for taking his view, a place whence the lake, the northern side of the Exposition, and the city extending behind the same may be seen. At the right is visible the Lake Michigan, at the left first the large cupolas of several Exposition palaces. A little more to the north are situated numerous American State buildings, and between these and the lake the German house, which with its graceful turrets and oriels stands out in a very picturesque relief from the Fair grounds. Farther in the background the city of Chicago displays itself, not a city in the European sense of the word, as only the center of the town will justify this appellation.

The visitor will see a quantity of groups of houses, which only at places impart the impression of completed streets and boulevards. These groups of houses are separated from one another by large lawns, swampy places, or wooded grounds. In the distance the buildings form a more compact mass, but are screened from the eyes of the spectator by the cloud of smoke which always floats above the center of the city of Chicago (39 miles long), the industrial town of Chicago sharing this nuisance with all other large industrial localities. The eye cannot cease admiring the city, which has, in fact, become a fairy city, which is still growing and showing the first stages of evolution, and which even reminds us of the times in which it was a swampy city. It may be said without exaggeration that the view of the environs of the Exposition building, as seen from the latter, is one of the most interesting features of the great and perhaps too large Columbian Exposition.—*Gustav Quade in Illustrirte Zeitung.*



THE WORLD'S COLUMBIAN EXPOSITION—A BIRD'S EYE VIEW.

FORESTRY EXHIBIT AT THE WORLD'S COLUMBIAN EXPOSITION.

THE finest forestry exhibit that the world has ever seen is at the present moment located in Jackson Park. Unfortunately, however, those who have visited it have not been able to properly appreciate it, owing to the fact that no catalogue has been published, though the Exhibition has now run half its allotted time. It is to be hoped that when at last the officials have prepared their catalogue, it will be of some use to visitors, and not, as is the case with a majority of exhibits, be a mere series of names of exhibitors and class of objects exhibited, without any description or further information of any kind.

The Forestry building is perhaps the one unique of all the great Exhibition structures, and is a grand and picturesque timber exhibit. It is of a rustic style of architecture, made entirely of wood, even the roof timbers being pinned with wooden pins. The only iron used is the nails in the floor, which covers an area of 2·6 acres. All around the outside of the build-

ing is a wide veranda whose roof is supported by a series of columns, each composed of three tree trunks, the central one of which is about 20 in. diameter and the others somewhat smaller. All these trunks are left in their natural state, with the bark undisturbed. They are contributed by the different States and Territories of the Union, each furnishing specimens of its most characteristic trees, each trunk being labeled with its name. The sides of the building are covered with thin overlapping wooden strips or shingles. The window frames are constructed of slabs with the bark removed. The roof is thatched with tan bark and other barks.

The building contains a varied exhibition of forest products, comprising logs and sections of trees, worked lumber in the form of shingles, flooring, panels, dyewoods, barks, abnormal woody products, resins, woodenware, such as pails, tubs, barrels, etc. There are exhibits by twenty five States in the Union, fifteen foreign countries, and thirty-one commercial firms.

In the center of the building stands a collection of the characteristic woods of all the countries exhibiting. Arching over this collection are two beautifully regular bamboo canes from Japan, each 70 ft. long. In the middle is a mammoth Californian redwood trunk, 14 ft. in diameter, in which is fixed a small brass pin showing the diameter of the wood at the time of the discovery of America, when the tree was already 475 years old, so that its age at the time of cutting down was 875 years. An object of considerable attraction in this collection is an ax lent by Mr. Gladstone, which that gentleman had employed in the felling of trees. The Argentine Republic exhibits as its representative wood the lapachio, a very heavy, dark red, brown wood of large size. New South Wales shows a beautiful rich red rosewood. Siam exhibits as characteristic the pradoo knot, a hard red brown and very irregular wood. Trinidad puts forward the fustic, a good dyewood of light yellow color. Paraguay is represented by the tatayba, an extremely heavy wood of a fine yellow color. Many other countries are also represented. The States have each also their characteristic specimens. New York and Wisconsin show white pine; Minnesota, black birch; Nebraska, black walnut; Oregon, larch; Missouri, persimmon and mulberry; West Virginia, yellow poplar; Idaho, red cedar; and Pennsylvania, sugar maple.

The different exhibitors adopt several methods for showing the timbers, the best of which, and one which is frequently adopted, is to have a trunk 3 ft. or 4 ft. high, with the bark on, cut through the middle for a length of about 1½ft., and then cut diagonally, so that a transverse section is seen on top, then a longitudinal section, and finally a diagonal section. One half of each of the sections is polished, nearly all the polishing being done by the Murphy Varnish Company. The tangential section, which gives usually so beautiful a grain, is generally shown in polished panels.

The polish on most of the specimens is extremely good. The process of French polishing, so much in vogue in Europe, is practically unknown here. The usual method is first to rub into the wood a mineral—siliceous—filler of a gummy consistency to fill up all pores. The surface is then cleaned and prepared by alcohol and shellac, after which three coats of varnish are applied and well rubbed down. Then it is rubbed with pumice-stone and water; and if an especially fine surface is desired, it is further rubbed with rottenstone, and the luster brought out by rubbing with the hand. Usually, however, it is finished off with an oiled cloth.

The North American and foreign exhibits will be treated in separate articles. The commercial exhibits are not very noteworthy. There are fine veneers, and all kinds of wooden ware. The Indurated Fiber Company show kitchen utensils, tubs, and pails, made of compressed wood fiber. They are very light, elastic, strong, odorless, and waterproof; and it is claimed that they are extremely durable. The Richmond Cedar Works Company exhibit pails and tubs of white cedar, in which the hoops are embedded in grooves, and are electric welded, so that the hoops cannot come off.

On the verandas are several immense logs, for which it is claimed that they are the largest of their species in the world. These include a black walnut from Kansas, 78 in. in diameter at base and 48 in. at top, and 47 ft. long; also a mahogany from Mexico 42 in. square and 41 ft. long. There is shown inside a redwood plank, which was cut from a tree 35 ft. in diameter, and about 1500 years old; the size of the plank is 16 ft. 5 in. wide, 12 ft. 9 in. long and 5 in. thick.

An interesting exhibit, not situated at the Forestry building, is the Michigan Logging Camp. This consists of a wooden house built of 18 in. hemlock logs, cut out or "saddled" at the corners to fit into one another, so as to allow each log to project for a few inches past the corner. The roof is built of 6 in. limbs, cut through longitudinally, and with some of the heart-wood taken out, so as to give them a concavo convex section. A layer of these is laid with their concave surfaces upward, and it supports another layer with convex surface upward in the same way that red curved tiles are set. The cabins are fitted up with all the appliances of the logger, and are very interesting. Outside is shown a logging train, consisting of a logging engine and low cars mounted on center swivel four-wheel trucks, with 24 in. wheels and 1½ in. center pins; such a train is used when the forest is at some distance from a river. In winter a level trench 8 ft. wide and 1 ft. deep is cut and flooded with water, so as to make a solid ice road over which the logs are drawn on sleighs by teams of horses. The largest load ever so drawn is on exhibit mounted on the sleigh. It weighs 144 tons, and contains 36,055 ft. of white pine 18 ft. long. The usual load is about 6000 ft. to 7000 ft. of timber, and is drawn by two horses.

The large variety of woods that occur in the innumerable North American forests is shown by no fewer than twenty-nine exhibits. Of these, twenty-five are by separate States in the Union; three are Canadian, namely, the British Columbian, Quebec, and Ontario exhibits; and one, which is taken from the Jessup collection in the American Museum of Natural History, is a comprehensive series, containing specimens of all the important North American woods, but does not include the Mexican woods. The last-mentioned exhibit, since it comprises all the others, will be treated of first, and in some detail. The specimens consist of short lengths of the trunks of trees, cut longitudinally through the central axis, and have one-half the section polished. Accompanying each specimen is a map of North America, on which the geographical distribution of the tree is represented by an area painted green.

A very common wood is the yellow poplar—*Liriodendron tulipifera*—confined to the east of the Mississippi, and growing to very large size. It is a light yellow color, compact, straight grained, and easily worked. Its specific gravity is 0·42, coefficient of elasticity is 1,320,000 lb. per square inch, and its modulus of rupture 9400. It is used for construction, interior finish, and especially for wooden pumps, wooden ware, etc.

Lignum vitæ occurs in Florida chiefly and the West Indian Isles. It is a low tree, not exceeding 25 ft. in height, very heavy, hard, strong, brittle, and compact. It is difficult to work. Its color is yellow to black in old specimens. The specific gravity of lignum vitæ is 1·14, its coefficient of elasticity 1,240,000, and its crushing strength 10,600 lb. per sq. in. It is used for sheaves of ships' blocks and thrust blocks.

The lime tree or basswood—*Tilia Amircana*—is a large tree of wide extension, growing on rich soil. It is light, soft, compact, easily worked, and a brownred color. Its use is largely for wooden ware and cheap furniture, also for turnery, bodies of carriages, etc.

The black ironwood—*Rhanmidium ferreum*—is remarkable in that it is the heaviest in the United States, its specific gravity being 1·3. Its coefficient of elasticity is 1,640,000, and resistance to crushing 11,500. It is a small tree, occurring in Florida and the West Indies, very hard, strong, brittle, compact, and difficult to work. Color is a rich orange brown.

The most important of the hollies in the exhibit is *Ilex opaca*, occurring in the Southeastern States. It is a medium sized evergreen, light, tough, rather hard, and very compact, and easily worked. Color nearly white. It is admirably adapted for cabinet work, interior finish, and turnery.

There are many species of maples shown. The sugar maple—*Acer barbatum*—is of great economic value, and great extent in the East. Maple sugar is obtained from it. Its coefficient of elasticity is high, 2,100,000. It is heavy, strong, tough, susceptible of a good polish. Color light brown. Its uses are almost universal. It grows in big trees often more than 100 ft. high.

Mahogany—*Swietenia mahogani*—is rare to the north of Mexico. It occurs as a large tree in Florida, the wood being of a rich red brown color, turning darker with age. It is heavy, very hard, strong, and durable, compact, and susceptible of a high polish. Its specific gravity is 0·72, modulus of elasticity 1,520,000, and crushing strength 9,600.

The locust—*Robinia Pseudacacia*—occurs east of the Rockies, and is not a large tree. It is heavy, specific gravity 0·73, extremely hard and strong, coefficient of elasticity 1,850,000, crushing strength 10,000. It is compact and very durable in contact with the ground. Color brown to light green. Used for trenails, posts, etc. Its cultivation is being abandoned on account of the attacks of the locust borer.

The hazel or sweet gum—*Liquidamber Styraciflua*—occurs largely in the South on low wet soil, and is a large tree, sometimes 150 ft. high and 6 ft. in diameter. It is a heavy—specific gravity 0·59—hard, tough, closegrained wood, difficult to season without much warping. Its color is bright brown tinged with red, and it takes a beautiful polish. Its uses are general.

The exhibit contains many species of ash, most of them valuable. The black ash—*Fraxinus Sambucifolia*—occurs largely in Newfoundland and Canada, and grows to a height of about 80 ft. It has a specific gravity of 0·63, coefficient of elasticity 1,250,000, and crushing strength 6,000. It is strong, cross-grained, and of a brown color. Used for furniture, frames of carriages, in cooperage, etc.

The catalpa of the Central States is largely used for railway ties, fence posts, and rails. It is a light, soft, brown wood, very durable in contact with the soil.

A beautiful specimen is the red bay—*Persea Borbonia*—a valuable but not abundant wood found in the South. It is bright red, heavy, hard, brittle, compact, and takes a beautiful polish. Used for interior finish and cabinet work. The mountain laurel—*Umbellularia Californica*—is a Pacific coast evergreen of large size. Its specific gravity is 0·65, coefficient of elasticity 1,520,000, and crushing strength 8,100. It is a rich light brown wood, hard, and compact. On the Oregon coast it is used in shipbuilding, for jaws, cleats, crosstrees, etc., also for interiors and cabinetwork.

Several of the elms are of great economic importance. The red elm—*Ulmus fulva*—which occurs over a large area in the East, is a dark brown or red wood, heavy, hard, compact, durable in contact with the ground, and splitting easily when green. It is largely used for fence posts, rails, and railway ties. The white elm—*Ulmus Americana*—has a still wider geographical distribution. It is a larger tree, growing to more than 100 ft. in height and to 8 ft. in diameter. It is a light brown color, strong, tough, and difficult to split. Used in boat and ship building, in cooperage, for flooring, etc. The rock elm—*Ulmus racemosa*—is of more restricted occurrence. It is heavy—specific gravity 0·73—its coefficient of elasticity is 1,560,000, and its crushing strength 8,500 lb. per sq. in. It is a light brown wood, hard, tough, and susceptible of a beautiful polish. It is much used in the manufacture of heavy agricultural implements, and for railway ties, bridge timbers, etc.

The sycamore—*Platanus occidentalis*—is the largest and one of the most beautiful of the Atlantic forest trees, and grows in a rich moist soil. It is often 120 ft. high, and 10 ft. to 12 ft. in diameter, and is very common. Its specific gravity is 0·57, coefficient of elasticity 1,240,000, and crushing strength 6,400. It is brown, tinged with red, not strong, compact, difficult to split and work. The medullary rays are very conspicuous. It is largely used for tobacco blocks, ox yokes, and butchers' blocks.

Several species of walnut are shown, of which two are in common use. The white walnut—*Juglans Cinerea*—is used much for interior finish and cabinetwork, but is inferior to the black walnut—*Juglans nigra*—which is more generally used for these purposes than any other North American wood. It is a very large tree, sometimes nearly 150 ft. high and 10 ft. in diameter. The wood is a rich dark brown color, heavy, hard, strong, liable to check, that is, to split through unequal contraction, if it is not carefully seasoned, easily worked, susceptible of a good polish, and durable in contact with the soil.

A brown-colored wood with nearly white sapwood is hickory. This wood grows to very large size, is heavy, very hard, tough, close-grained, and flexible. It is used very largely in the manufacture of agricultural implements, carriages, hubs, and spokes of wheels, ax handles, baskets, etc. Its specific gravity is 0·84, coefficient of elasticity 1,980,000, and crushing strength 9,000.

Numerous specimens of oaks are shown. Of these the best is the white oak (*Quercus alba*), which grows to very large size, and is largely used in shipbuilding construction, for railway ties, fencing, cabinet making, and many other purposes. It has a brown color, and broad and prominent medullary rays. Its specific gravity is 0·75, coefficient of elasticity 1,390,000, and crushing strength 7,300.

A specimen of the chestnut (*Castanea sativa*), a light, soft, coarse-grained wood of a brown color, is shown. It is very durable in contact with the ground, and so is used for railway ties, posts, and fences. It is easily split and liable to check and warp in drying.

The beech (*Fagus ferruginea*) has a wide extent in the North, and grows to great size on borders of swamps. It is a hard, tough wood, quickly rotting in contact with the soil, difficult to season, and takes a fine polish. Its coefficient of elasticity is high, 1,730,000. The color varies much, but is dark, and the sapwood white. Used in manufacture of chairs, handles, etc.

Many varieties of birch are shown. The yellow birch—*Betula lutea*—is one of the largest and most valuable trees of the Northern Atlantic forests, and is remarkable for its high coefficient of elasticity, 2,300,000. It is a light brown wood tinged with red, heavy, hard, compact, satiny, and takes a high polish. It is largely used for furniture, and hubs of wheels, also for pill and match boxes, as it cuts very thin, and bends without breaking. The cherry birch—*Betula lenta*—is a very valuable wood of the northern forests. It is largely used for shipbuilding in Nova Scotia and New Brunswick. There is a fine series of alders exhibited, the most important, economically, being *Alnus rubra*, a Western tree of large size. The wood is of light brown color, light, soft, brittle, very close-grained, and satiny. Its use is chiefly for furniture.

Poplars or cottonwoods are shown in many beautiful specimens, and are used for panels. The best poplar of the eastern coast is *Populus grandidentala*, a light brown, soft wood, largely manufactured into wood pulp and wooden ware generally.

The cedars and cypresses are represented by some fifteen specimens, nearly all of which are from the Pacific coast. They are very durable in contact with the ground and in water, and hence their use for posts, railroad ties, boats, ships, etc.

The red cedar—*Thuya gigantea*—grows to very great size. It is dull brown, tinged with red, light, soft, brittle, coarse grained, and easily worked, and is one of the most valuable Western woods.

Port Orford cedar—*Chamæcyparis Lawsoniana*—is a tree of the first economic value, growing sometimes to a height of 200 ft. and a diameter of 14 ft. It is a light yellow wood, hard, strong, compact, light, abounding in odoriferous resin, and taking a beautiful polish. It is largely used for interior finish; flooring, railroad ties, fence posts, and in ship and boat building.

The typical California tree is the immense redwood—*Sequoia gigantea*—which may attain a height of 350 ft. and a diameter of 35 ft. It is very light, specific gravity 0·288, and is not strong, but is very durable in contact with the soil. Its color is a bright clear red, becoming darker on exposure. It is used locally for fencing, shingles, and construction.

The pines occur in the greatest variety; no fewer than thirty-five species are exhibited. They are by far the commonest of the American woods, and the most generally useful. They may be said to occur all over the country, though, of course, the habitat of any species is limited. Of white pines there are several, but *Pinus strobus*, occurring in the region of the Great Lakes, is the most valuable. It often attains great dimensions, is light, soft, straight grained, and easily worked. Its specific gravity is 0·38, coefficient of elasticity 85,090, and crushing strength 339. It is more largely manufactured into lumber, shingles, laths, etc., than any other North American wood, and is the common and most valuable building material of the Northern States. *Pinus ponderosa*, a yellow pine, is a wood of almost equal value on the west coast. It sometimes grows to the immense height of 300 ft., and to 14 ft. diameter. It varies much in quality and value, is hard, heavy, strong, brittle, and not durable. It is a light red color, and is used for railway sleepers, fuel, etc. *Pinus palustris*, the Georgia pine, is of importance, since the turpentine, tar, pitch, resin, and spirits of turpentine manufactured in the United States are almost exclusively produced by this species. It grows in the dry sandy loam of the maritime plain, and is largely used for shipbuilding, fencing, railway ties, etc.

Six species of spruce appear in the collection, of which the black spruce—*Picea Mariana*—and the white spruce—*Plaxa*—are the most important. Both occur very largely in Canada, and are largely exported. The black spruce grows best in light dry rocky soil, but does not exceed 65 ft. in height. It is light, soft, not strong, compact, and satiny, with conspicuous medullary rays. The white spruce grows to a greater height, and is a light yellow color. The two are scarcely distinguished in commerce, and are used for construction, shipbuilding, piles and posts. The hemlock is of common occurrence in many parts of the country, and is chiefly esteemed for its bark, which is rich in tannin, and is the principal material used in tanning leather. The northeastern variety, *Isuga Canadensis*, is a light brown wood tinged with red, the sapwood being darker. It is soft, light, brittle, crooked grained, difficult to work, and not durable. Its use is chiefly for outside finish and rough work in general.

A fine specimen is exhibited of the red or Douglas fir—*Pseudosuga taxifolia*—the most generally distributed and most valuable timber of the Pacific coast. It forms extensive forests, almost to the exclusion of other species, and is generally from 200 ft. to 300 ft. high, with a trunk up to 11 ft. in diameter. The wood is of a light red to yellow color, with nearly white

sapwood. Its specific gravity is 0·5157, coefficient of elasticity 1,840,000, and crushing strength 7400 lb. per square inch. It is hard, strong, difficult to work, and durable, and varies greatly with age and conditions of growth in density and quality. It is largely exported and used for all kinds of construction, piles, etc. There are numerous other firs, but not of much economic importance.

The larch is usually known as tamarac, and is very largely exported to England and elsewhere. The black larch—*Larix Laricina*—occurring in the Northeast, is a tree growing on moist land and attaining a height of 80 ft. It is a heavy, hard, strong wood of specific gravity 0·62, coefficient of elasticity 1,800,000 and resistance to crushing 7600. Its color is light brown, and it is very durable in contact with the soil. It is preferred and largely used for ship timbers, fence posts, telegraph poles, etc. Another larch—*Larix occidentalis*—which occurs in the West, is remarkable for its very high coefficient of elasticity—2,350,000. It is a large tree, 90 ft. to 150 ft. high, abounding on moist mountain slopes. The wood is heavy, exceedingly hard, coarse grained, satiny, susceptible of a high polish, and very durable in contact with the ground, and so is largely used for posts.

A curious ragged-looking specimen is the cabbage tree—*Sabal Palmetto*—which is very highly esteemed for wharf piles on account of its imperviousness to the attacks of the teredo. It grows on the southeast coast on the sandy maritime shores, attaining a height of from 20 ft. to 40 ft. It has a light, soft wood, with hard, fibro-vascular bundles of a dark color, which make it difficult to work.

A wood of small size but of some economic value on account of its hardness is hornbeam—*Ostyra Virginica*. It is of light brown color, heavy, specific gravity 0·83, very strong and hard, tough and durable. Its use is chiefly for posts, levers, handles of tools and the teeth of cog-wheels.

Turning now to some of the more important State exhibits, attention is at once claimed by that of the Empire State, New York, which, though it is not richest in its varieties, is so well presented as to make it by far the most interesting. The exhibit is quite a model one, from which all future exhibitors would do well to copy. It consists of the following exhibits for each of the 100 species shown. There is a part of the trunk with bark on, about 3 ft. high; this is cut so as to show the appearance of the wood in longitudinal, transverse and diagonal sections, one-half of each section being polished.

These specimens have nearly all been cut down within the past few months, and to allow of their being quickly seasoned have had the heartwood cut out through the greater part of their length, which, however, does not show, as the trunks stand on end. Each trunk has also been sawn in two, longitudinally, to facilitate the same operation and to prevent cracking. For each wood there is a frame usually of that wood, mounted on a pivot, and containing specimens of the foliage, flowers and fruit—artificial if necessary—of the tree, and photographs of the same tree, both in summer and winter, the two views being taken from the same point, and having some object present with which to compare the height of the tree. The trees chosen are always typical ones which have grown up by themselves uninfluenced by the presence of others.

There is also a full-sized photograph of the bark of each tree, and three thin sections, radial, transverse, and tangential, of wood. These sections are very perfect, about 4 in. by 3 in. area, and $\frac{1}{125}$ in. thick in the radial sections, and $\frac{1}{16}$ in. in the transverse. They are so mounted that they can be looked at by reflected light giving the appearance of that section of the wood, and by transmitted light showing the structure. A still more remarkable series of sections is mounted as transparencies in front of the windows. The sections are only $\frac{1}{125}$ in. thick, and perfect. They were cut by the collector of the exhibit, Mr. R. H. Hough, with a machine of his invention. The exhibit shows the chief woods of the State to be white pine, black spruce, ash, and hemlock.

The State of Ohio has an exhibit which is to form the nucleus of a permanent collection in the State University. It consists of a series of frames containing cross and longitudinal sections of the wood, part of the bark, a twig showing condition in winter, leaves, flowers and fruit of each of the characteristic trees of the State. There is also a series of polished panels, showing the appearance of the wood in radial, tangential and diagonal sections. The characteristic woods are oaks and pines.

The exhibit of North Carolina is a valuable one. Large photographs of the chief timber trees, and methods of felling them, accompanying an extensive series of polished planks. Some beautiful white Spanish and chestnut oaks are shown. Other woods for interior finishing and cabinet work are curly poplar, white and black walnuts, red cherry and sweet gum. Sycamore also flourishes in the State, and as it cuts up very thin, is used for tobacco and cigar boxes. Red cedar and cypress are common, and as they are nearly impervious to water, are in great request for water buckets. The most important wood is the long leaf pine, used in civil and naval architecture.

Missouri has a good exhibit of trunks, showing all the sections, and of polished panels. The chief woods shown are black hickory, much used for axles, and sold for $10 per thousand in the log; cottonwood, which is the common cheap lumber, value $3 to $4 per thousand; and sweet gum, selling for $10 as lumber, and used for interior finish. Some very large specimens of less common trees are also shown, many of them being too large to accommodate within the building, and consequently left outside. Trunks of the aromatic sassafras, 3 feet in diameter; of the black-hearted persimmon, and of the orange colored mulberry, 2 feet 6 inches in diameter; of cypress, 6 feet in diameter; and of oak, 7 feet in diameter, are shown among other equally large specimens. Beautiful panels of honey locust, dogwood, sassafras, and many other woods show further the richness of the State as a forest country.

West Virginia and Michigan also have very fine exhibits, both including a number of specimens showing the ravages by insects, and also the insects responsible for each particular case. West Virginia exhibits immense blocks of spruce, beech, chestnut, red and white oak, birch and gum, showing the three chief sections. It is very rich in ornamental woods, which are shown in panels, and include mulberry, dogwood, red cedar, honey locust, butternut, Spanish oak, cherry, quartered sycamore, curly beech, calico, white and many other poplars, and white ash. The most common wood is yellow poplar, selling in the cities at $17.

Of the Pacific States, the exhibit of California consists chiefly of redwoods—*Sequoia*—which are of enormous size, the bark of one specimen alone being 24 inches thick. The most beautiful of the redwoods shown is *Sequoia sempervirens*, which is a dark red color. The other woods are chiefly walnuts, myrtle, laurel, yellow pine, white cedar, and oaks.

Oregon, a State producing fine timber, has but a poor exhibit. Large planks are shown of its most important timber, the Douglas pine or red fir, which is largely exported to the shipyards of Europe for masts and spars, and which, according to Lloyd's tests, stands 2,000 lb. per square inch in tension. It fetches $10 per thousand in Oregon. The tideland spruce is another wood of great importance there, and largely used in construction; its value is $10 per thousand. The well-known Port Orford cedar is another product of this country, very durable and odorous, fetching $50 per thousand. The State sends East about 10,000,000 ft. of timber per month. Of the exhibits of the other States in the Union, the most noticeable are those of Indiana, Wisconsin, Minnesota, Colorado, Washington, and Kentucky.

The exhibits from Canada are three in number, and show but inadequately the immense timber resources of that country. The province of Ontario exhibit consists of a number of trunks cut so as to show the three principal sections, and of a number of planks and polished panels. The most abundant wood is the red pine, which sells for $10 per thousand. White pine of a very fine character, free from knots, is much used for doors and sashes, and fetches $20 to $30. Soft maple is abundant, and used for flooring; it is valued at about $14. Tamarac—larch—is largely employed for outbuildings and rough work generally; it fetches $10 per 1,000 ft. Of the woods for interior finishing and cabinet making, the most common are basswood for cheap goods, $12; red oak, $18; elm, largely used for cheap furniture, as it takes all kinds of stains and polishes well; black ash and black birch, which is now taking the place of walnut.

The exhibit of the province of Quebec does not show very different specimens. The prices there for timber delivered at the mills are: White pine, $8·90: white spruce, $5; white cedar, $5·50; tamarac, $5; red oak, $10; and black cherry, $12.

The British Columbia exhibit is remarkable for the large size of the timber shown. The most important wood there is the Douglas fir, which grows to such a vast size, and of such good quality, that planks 100 ft. to 120 ft. long and 4 ft. wide can be cut without showing any irregularity of structure; such wood sells for $10 per 1000 ft. The trees grow to a height of 300 ft. to 250 ft., and are cut off about 15 ft. above the ground, because the roots come up to near that height, and the contained pitch at the bottom of the trunk makes it very difficult to cut. One log of Douglas fir gave 25,400 ft. of lumber. It was 136 ft. long and the diameters at its ends were 6 ft. 6 in. and 4 ft. respectively. The wood is red and is largely exported to Australia to the mines there. A wood of nearly equal importance and size is the white spruce, of which a plank 5 ft. 9 in. wide, cut from a portion of the trunk 48 ft. above the ground, is shown. Its selling price is the same as that of Douglas fir. The only wood used extensively for interior work in British Columbia is red cedar, which takes a beautiful polish, but is very soft. Its texture is so regular that very large planks of uniform thickness and nearly smooth surface can be easily stripped off a log. As it may be desirable to see at a glance the strength of the more important North American timbers, they are collected and tabulated here:

Name of wood.	Specific gravity.	Coefficient of elasticity in lb. per sq. in.	Crushing strength in lb. per sq. in.
Yellow poplar	0·42	1,320,000	5,300
Lignum vitæ	1·14	1,240,000	10,600
Ironwood	1·3	1,640,000	11,500
Sugar maple	0·69	2,100,000	890
Hazel or sweet gum	0·59	1,250,000	6,700
Black ash	0·63	1,250,000	6,000
Rock elm	0·73	1,560,000	8,500
Sycamore	0·57	1,240,000	6,400
Black walnut	0·61	1,560,000	8,700
Hickory	0·84	1,980,000	9,000
White oak	0·75	1,390,000	7,300
Yellow birch	0·66	2,300,000	8,800
Red cedar	0·38	1,470,000	6,450
Port Orford cedar	0·46	1,730,000	6,700
Redwood	0·288	650,000	5,500
White pine	0·39	1,220,000	4,900
Yellow pine	0·47	1,240,000	5,400
Black spruce	0·46	1,580,000	5,800
Douglas fir	0·52	1,840,000	7,400
Black larch	0·62	1,800,000	7,600
Hornbeam	0·83	1,950,000	7,800

—*The Engineer.*

THE FIBER CULTURE OUTLOOK IN THE SOUTH.

By EUGENE MURRAY AARON, Ph.D.

As with forage plants, so it is with the fiber-yielding growths, a great botanical divergence is observable in them; and these botanical differences naturally call for different cultivations and treatments. Such widely separated families as the nettles and hemps (Urticaceæ), Spanish daggers (Liliaceæ), palms (Palmaceæ), peas (Leguminosæ), flaxes (Linaceæ), aloes or century plants (Amaryllidaceæ), and the jutes (Tiliaceæ) furnish those fibers for which at present there is a well known call. Taking these in their order, the following preliminary remarks will serve to make the classification more simple by eliminating from the list several sorts that are not of special interest in this connection, as being of little or no practical value to the Southern farmer.

It is from among the nettles and hemps that the Southern farmer is likely to select some of the best fiber-producing plants in the future, but their selection will illustrate how inaccurate is usually the use of common or local names when applied to plants, for these will come from the widely separated families of the peas, aloes, and stingless nettles. These yield the Sunn, Sansiveria, Sisal, Russian, and Indian hemp, as well as that prince among fiber yielders, the Ramie plant. The least valuable of these is the Sunn hemp, a species of rattle pod (Crolalaria juncea) belonging to the pea family, and yielding a low grade and low-priced fiber that is being crowded from the markets by the more productive and higher grade sorts that have recently sprung into favor. Following this in the scale appear the Russian or Italian hemp, as it is sometimes called, and the well known Indian hemp (Cannabis sativa and C. Indica). The first of these is indigenous, the latter has been introduced and is now quite common as an ornamental plant. Both are even more remarkable for their strong narcotic properties than for their fibers, which, while of a fair grade, are each year meeting a weakening market. From the Russian hemp "gunjah," a preparation of the dried leaves, is made and smoked; and when pounded in water it is drunk under the name of "bhang." It is the resin of this species which produces among the natives of Lower Russia the peculiar forms of nervous excitement followed by extreme prostration of which many observers have given us graphic accounts. Its use in cumulative doses finally leads to delirium, catalepsy, and at last to insanity, if death has not already stepped in to end the torments of the "gunjah fiend." The Indian hemp yields an equally virulent narcotic, familiar to us under the name of "hasheesh," a most seductive and insidious compound with all the delights of opium, and more, and threefold its health-destroying qualities.

This same family (Urticaceæ) comprises among others that genus of false or stingless nettles, Bœhmeria, from which is derived the ramie fiber (B. nivea*), now generally acknowledged by experts and growers to be the most promising of all fiber-producing plants known to agriculture. For centuries the Chinese have used this fiber, commonly there called "rhamia," as an adulterant for silk, which it mimics in appearance as does no other vegetable substance known to the trade. All who examined the very complete exhibits of fibers in the various stages made by Messrs. Ide & Christie, of London, at the Jamaica Intercolonial Exhibition of 1891, were struck by the beautiful white silky texture, remarkable fineness and softness, and the great strength of the specimens of ramie exhibited by them. By them such fibers as those of the flaxes, Sisal hemps, jute, and the other common fibers were coarse, unequal in texture, and none of them excelled ramie in pliability or strength. Naturally all who felt an interest in this promising plant first inquired why it was that such self-evident fibrous excellence should be so neglected that these exhibitors were forced to report that the annual supply then reaching London was not even equal to what would be the weekly demand were it to come to be an article of steady and reliable import. The answer was the same that so long stood in the way of the Sisal hemp industry outside of Yucatan, where for many years it was grown only to be exported in the crudest forms of hand-made ropes and hammocks. The difficulty of finding some adequate method of decorticating this fiber, some machine or process that would have commercial value, and warrant the grower in devoting large acreages to this crop, was all that was in the way. Unfortunately, what was true at that time appears yet to be the main cause of hesitancy on the part of growers to try experiments with a fiber that, so soon as this problem is solved, cannot help but add very considerably to the agricultural wealth of the regions best suited to its growth. I am aware that there are at this time a number of machines on the market for which claims of a very comprehensive nature are put forth; but to quote Mr. Charles Richards Dodge, the special agent in charge of fiber investigations for our Department of Agriculture, speaking, in a recent report, of one of the best of these: "With a single machine it required 25 days to decorticate the product of a hectare, or $2\frac{1}{2}$ acres. With 20 acres, at this rate, it would have required 200 days, and a farmer with one machine, decorticating three crops produced in a season, on 100 acres, would have to run the machine ten years, of 300 working days each, to accomplish it. To state it differently, to decorticate at this rate the product of a single cutting on 100 acres, in one month of 30 days, would require 11 machines." And these machines are much more expensive than are most agricultural machines; one that I had an opportunity of examining in New York City recently, which its inventor claimed was able to double the output of the one referred to by Mr. Dodge, cost about $400. Even with its added speed six machines would be required to promptly decorticate the growth from 100 acres, and the very disproportionate expenditure of $2,400 for decorticating machinery for every 100 acres of cultivation would be called for—a state of affairs quite certain to deter the farmer from a further consideration of this crop at present. That is, unless he be of an inventive turn of mind, in which case I can think of no expenditure of leisure time that would yield a better return than would that given to the successful solution of this problem of ramie decortication. A system that will be like that now growing so popular in Louisiana and elsewhere in sugar-growing countries, whereby central stations are established to cater to the mechanical wants of the surrounding small growers, would seem to be in the direction of a successful solution; and he who can place before his fellows a process that will make such central decorticating mills of vast capacity possible will confer a lasting benefit on Southern agriculturists and all users of textile fabrics, and will place his name on the same scroll of honor with those of Whitney, Howe, Jaquard, and all that illustrious list.

At this writing nearly every one of our Southern States contains one or more ramie plantations, Louisiana and Texas taking the lead. The State of Vera Cruz, in Mexico, has also done much with this growth, and it is there that some of the most conclusive tests of fiber machinery have been made; tests that have been far more productive of the blighted hopes of inventors than of a solution of this vexed decorticating problem. Mr. Felix Fremerey, of the Ramie Planting Associa-

* I am aware that there are other species of this genus now being cultivated, notably B. canticans, tenacissima, et al., and that attention has even been given to the indigenous species B. cylindrica, but as there is much uncertainty on the part of botanists relative to the specific differences of those cultivated, I have considered all under the one scientific name.

tion, of Yorktown, Texas; Mr. Burnet Landreth, President of the Ramie Company of America, of Philadelphia; Mr. Morris, of the Royal Botanical Gardens at Kew, England; Mr. Fawcett, Botanist to the Jamaica Government, and Mr. Charles Richard Dodge, already quoted, are all gentlemen who can be relied upon to furnish to the novice much valuable advice. Mr. Dodge, especially, by reason of his official position, either through his publications or by letter, can be called upon for reports upon the latest advances in this most promising industry.

The great productivity and value of the ramie crop, outside of the decorticating difficulties, I have purposely left to be the last consideration, as it is much better in such matters to have the cold water thrown on first. Along the Gulf coast of this country ramie should yield four crops a year; it has been cultivated from New Jersey, where two crops are possible, to the State of Chiapas, Mexico, where seven are a common thing. It may be propagated either by seed, by cuttings or layers, or by division of the roots. The seeds being very minute call for great care in open air planting, hotbed forcing being best at the first. But the most satisfactory method is undoubtedly that of the division of the roots of the well developed plants. There is much diversity of opinion as to the methods of cultivation, especially with reference to close planting, the French favoring 2 ft. apart each way, 4 ft. being the standard in India, while our own department favors cross-furrows 5 ft. apart. But all are agreed that while ramie will flourish wonderfully on very indifferent soil, "a rich loam suits the plants best, but they will grow in any kind of soil, provided a full supply of moisture be available, combined with thorough drainage," to quote Mr. Montgomery, writing of the Kangra district of India. While this demand for an abundance of moisture will in some localities call for irrigation, it must be borne in mind that ramie is a crop that will not thrive in wet soil. From careful cultivation along such lines as are fully set forth in the comprehensive pamphlets issued by our Department of Agriculture, may be produced a crop, from a field over a year old, with stems reaching an average height of 6 ft., that will yield 48,000 pounds per acre of green cuttings, from which 27,600 pounds of stripped stalks may be extracted. "It is claimed that Louisiana ramie produces 250,000 stalks per acre. . . . In France, it is claimed, by estimates based on the weight of stalks that can be produced on a hectare, and after considering the expenses of cultivation and decortication, that an income of 1,500 francs per hectare is possible the third year. This is equal to about $120 per acre." —Dodge.

It is unfortunate that in the past so much of the literature of fiber culture that has appeared in this country has taken on only the most roseate hues, preferring to ignore the present lack of adequate decorticating processes. Having set these forth, however, I think I may not unfairly end this consideration of ramie culture by the following quotation from Mr. Dodge's Report No. 1:

"In China and Japan, where the fiber is extracted by hand labor, it is manufactured not only into cordage, fish lines, nets, and similar coarse manufactures, but woven into the finest and most beautiful of fabrics. In England, France, and Germany the fiber has also been woven into a great variety of fabrics, covering the widest range of uses, such as lace, lace curtains, handkerchiefs, cloth, or white goods resembling fine linen, dress goods, napkins, table damask, table covers, bedspreads, drapery for curtains or lambrequins, plush, and even carpets and fabrics suitable for clothing. The fiber can be dyed in all desirable shades or colors, some examples having the luster and brilliancy of silk. It is one of the strongest and most durable of fibers, is least affected by moisture, and from these characteristics must take first rank in value as a textile substance."

Jute (Corchorus olitorius and C. capsularis) has been and is now successfully cultivated in this country, but the same decorticating problem which faces the ramie industry applies to this growth, and, as it is a soil-exhausting crop, it is doubtful whether, when that problem is solved, it will ever come into very general cultivation.

Flax (Linum usitatissimum) from the standpoint of the agriculturist is an established fiber crop in the United States, but from the standpoint of the tariff expert (?) is or is not a possible crop, as may best please him in the argument. At the present time it is grown more for the seed than for the fiber, and as much of the latter which reaches the manufacturer has been imperfectly prepared for his uses, it has not the reputation that more care can be made to earn for it. However, as it is a well known crop and one that appeals more to the farmers of New England or Wisconsin than to those of the South, it may be passed with simple mention.

The palm fibers, while their cultivation is possible in the lower stretches of Florida, are not of sufficient excellence and productivity to entitle them to more than passing consideration. From the dwarf palm a fiber closely resembling coarse horsehair is produced; from Madagascar and Brazil the "Piassava" palm fiber yields a finer and stronger thread; raffia (Rhafia) grown in the brackish swamps of the tropics and only good for mats and coarse carpetings; and the "coir" fiber from the common cocoanut palm (Cocos nucifera), always very durable and in fair demand in the London market, are among the principal palm fibers. The latter, and perhaps the hat palmetto (Chamœrops humilis), hardly a true fiber plant, are the only palm fibers likely to prove of lasting value in the district named.

There are other fibers, which at this time are to be classed as of minor importance, however much careful cultivation may hereafter advance them in the estimations of fiber producers and fiber users. Among these may be mentioned okra (Abelmoschus esculentus); swamp rose-mallow (Hibiscus moschentos); Indian mallow or "American jute" (Abutilon avicennæ); the pineapples (Ananassa and Bromelia species); Spanish bayonet or Adam's needle (Yucca species); and bear grass (Dasylirion graminifolium). Several of these give promise of taking an important rank when the cultivation and treatment is better understood, but it suffices now to point them out as fiber yielders worthy of closer acquaintance on the part of Southern agriculturists.

There now remain to be considered only the aloes or century plants (Amaryllidaceæ), among which the now famous Sisal hemp or "henequin" (Agave Americana and its varieties or congeners) is the most valuable. Mr. Dodge, in treating of this growth, considers the Sisal or Yucatan hemp, now also produced in large quantities in the Bahamas and others of the West Indies, a variety, Sisalana, of our indigenous Agave rigida, which is by no means uncommon in South Florida and on the outlying keys. So much has been written of this plant, and the almost miraculous revolution which it has worked in the wildernesses of Yucatan and on the barrens of the lower Bahamas, that it is hardly necessary to add anything here. It may not be out of place, however, to state that the too prevalent notion that Sisal hemp may be planted almost haphazard on the most barren ground and for years to come yield an abundance with no other attention than is required to harvest it, is based on an entire misapprehension of the facts. I cannot do better than quote from Mr. Edgar Mayhew Bacon in this connection:

"To be successful in this enterprise requires unceasing activity and care. One must be Argus-eyed. . . . There is no cultivation where system and perseverance are more necessary to success. The dropping of seed from a single 'pole,' if not watched and attended to immediately, will produce little spears enough to destroy a hundred plants, and I have frequently seen a dozen suckers start up around and under the leaves of their parent. After such crowding the leaves would be worthless, even could they be reached; but no man, unless arrayed in metal armor strong and stout enough to withstand the thrust of steel, would be so foolhardy as to attempt to penetrate such a growth. What I want to impress is the fact that, without patient and systematic care, which I nowhere observed as characteristic of the unled negro, a field of sisal is as valueless as a field of mullen."

Sisal hemp, however, can hardly be regarded as a safe crop within the frost lines; it is, as a consequence, relegated to a very inconsiderable and as yet very thinly settled region of our land. Ramie, on the other hand, if the higher elevations of the Appalachian system be excepted, is suited to every one of our Southern States, and is eminently fitted to wrest a competency from many a field not now under any cultivation save that of the ubiquitous "sedge grass." The one barrier, that of a practical method of decortication, alone remains; when that is removed, ramie fiber culture is destined to rank alone second to King Cotton in agricultural importance.

THE GEOLOGIST AT BLUE MOUNTAIN, MARYLAND.

By CHARLES D. WALCOTT.

MOST of the summer visitors at Blue Mountain, Maryland, give little thought to the origin of the mountain, nor how it came to be a ridge rising so boldly on the west from the Cumberland Valley and on the east overlooking the mountain valley to the foot of the Catoctin ridge, which rises above the plain stretching thence southeastward to Washington.

During the summer of 1892 the writer discovered that the rocks forming the crest of the Blue ridge belong among the oldest formations deposited in the Appalachian trough, since they carry types of life occurring in the most ancient fossiliferous rocks on the North American continent that are distinguished by a recognizable fauna; the geologic structure also shows that these rocks rest upon the ancient sea bed of the Appalachian trough, and that they are of the same relative geologic age as the Cambrian rocks that occupy an equivalent stratigraphic position in Vermont, New Jersey, New York, Virginia, and Tennessee.

The recent work of Dr. G. H. Williams demonstrates that, with one partial exception, the older crystalline rocks underlying the Cambrian strata have hitherto been misinterpreted and misunderstood by the geologists who have studied them. Instead of being sedimentary formations originally deposited in the sea bed, they are volcanic rocks and almost identical with the lavas found in Nevada, Wyoming, and in many portions of the Rocky Mountain region. This discovery proves that the laboratory of nature produced a certain type of volcanic rock almost at the beginning of the evolution of the North American continent, and again produced the same type many millions of years afterward on the western side of the continent.

The broad mountain crossing the Pennsylvania-Maryland line includes eastern and western border ridges and an intervening valley. On the western or Blue ridge side it is built up of sedimentary rocks originally deposited in the sea on the bottom and, it may be, the side of the Appalachian trough. In the intervening valley it consists to a considerable extent of eruptive rocks, which poured out as flows the ancient land surface prior to the existence of the Appalachian trough and before the deposition of the stratified rocks which so largely form the North American continent within the limits of the United States. The elevated eastern side forms the Catoctin ridge, which is capped by a compressed fold of the old shales and quartzites. Both ridges continue south of the Maryland line toward Harper's Ferry and far into Virginia as compressed synclinal folds of the Cambrian rocks, resting on the rocks of the ancient Appalachian trough, the older rocks and the more recent rocks having been involved in the same series of folding.

In addition to this folding, numerous thrusts of one mass of rocks upon another are to be found all along the Blue ridge, especially north of the Pennsylvania-Maryland line, in the northern extension of Blue Mountain, or the South Mountain of Pennsylvania. In some instances the ancient eruptive rocks have been thrust westward, so as to rest upon and above the more recent sandstones and shales which were originally deposited upon them in the bottom and along the shores of the Appalachian trough. Often the pressure has cleaved the massive lavas and formed slates and shales that appear like those deposited in quiet waters. The result of this has been to complicate the geologic structure and topography of South Mountain and the Blue ridge, and to make the region one of great interest to both professional and amateur geologists. Erosion has aided their study by cutting away thousands of feet of strata from above the present mountain area and adjacent valleys, and thus laying bare a portion of the ancient shore line of the Atlantic coast area of Cambrian time and of the foundation upon which much of the present continent is built.

The history of the Blue ridge and its rocks as now interpreted is essentially as follows:* It began long after the first known primitive rocks of the earth were raised into plateaus and ridges to form the platforms of the present continents. At the close of the periods in which the earlier crystalline rocks of the continent were formed, and also the great masses of bedded rocks beneath those containing the Cambrian or oldest known fauna, that portion of the North American continent then above the sea is thought to have consisted of (1) a large part of what is now the British possessions; (2) a long, broad mountain area (Atlantic) extended southwestward from Newfoundland to the present site of the Gulf of Mexico, and it may be the West Indian archipelago; (3) and one or more areas (Pacific) on the western side of the continental plateau, on the line of the present Rocky Mountain and Sierra Nevada ranges.†

The eastern or Atlantic area and the bed of the interior sea toward the west, in what may be called the Appalachian trough, were then formed of various kinds of rock, including granite, schists of various kinds, cystalline and unaltered sedimentary rocks and, in some localities, of great masses of volcanic material that had been poured out over the surface in very much the same manner as were the relatively recent lavas found in the vicinity of the Yellowstone National Park and in various parts of the Rocky Mountain region.

The waves of the interior sea wore away from the western shore of the Atlantic land area various rock materials and deposited them along with that brought in by the brooks and rivers as layers of sand and gravel on the sea bed all the way from the present site of the St. Lawrence River to Alabama. In these deposits fragments of the volcanic rocks, schists, etc., were mingled, and spread out in sheets. At times the supply of material was very fine and formed thin layers of mud that afterward consolidated into shales and slates. After a deposition of several thousand feet of this character of materials the water deepened, probably by the subsidence of the bed of the sea, and calcareous muds were deposited during a great interval of time until in places they reached the thickness of several thousand feet.

These now form the limestones found in the Cumberland and Shenandoah Valleys and their extensions northward to Canada and southward to Alabama. All along this ancient coastline, from Labrador to Alabama, various forms of marine life existed, and their hard parts, such as shells of crustaceans (allied to the living king crab) and other organisms, were buried in the mud and sand.

The deposition of sediments in the sea, immediately west of the Atlantic area, continued until from 12,000 to 40,000 feet in thickness were piled over the ancient sea bottom, layer upon layer, sometimes of one kind of sediment and sometimes of another. These are now found as layers of sandstone, limestone, coal, shale, slate, and various combinations of sandstone, shale, etc. With the close of the first great age (Paleozoic) in sedimentation in the Appalachian trough the earth's forces again became active, and sufficient pressure was exerted from the Atlantic coast side of the continent to raise this great mass of sediments above the sea and to fold it in ridges and hollows, very much as layers of paper or cloth would fold from pressure applied to the edges of the layers if they were partially confined above and below. This was varied, however, in the great rock masses by the frequent shearing on the line of the folds and the thrusting of masses of rock one over the other, as cards shift over each other under pressure. One of these folds, with minor folds within it, has by subsequent agencies been carved into the Blue ridge.

The epoch of folding was several millions of years ago; so long since that sufficient time has elapsed for thousands of feet of sediments to be deposited in the interior lakes and seas of the North American continent, and for animal life to develop from the then highest types of fish and reptile to the higher mammals, at the head of which man stands to-day.

During the thousands of centuries since the first great Appalachian uplift, the rain, frost, and snow have been at work sculpturing the old land surface and slowly working out the mountains, valleys and plains. It is not improbable that the process of mountain uplift and that of wearing away the mountains to a relatively level area (base level of erosion) may have taken place several times, the intervals of rest between the wearing away of the highland and mountains and the succeeding epoch of uplift being of long duration—so long, in fact, that centuries might pass without effecting a marked change in the relations of the land and sea.

It was not far back, geologically speaking, that the Blue ridge was a part of, and not distinct from, a great plain that was broken by low hills and valleys and drained by streams flowing into a river that occupied relatively the same position that the Potomac does now. The continent was then at a lower level in relation to the sea, and it was not until it became elevated that the Potomac began to cut down into its bed in the old plain and carry out to the ocean the material which filled the areas now represented by the Cumberland and Shenandoah Valleys. As this process continued and the river lowered its channel the Blue ridge began to take shape as a distinct feature in the landscape. Slowly but surely the softer beds were broken up, dissolved and carried away, and the harder beds of rock began to project above the ancient plateau. It was only the question of which beds of rocks could the longer resist the forces of rain and frost to determine the location of mountains and valleys.

We have thus hastily sketched the evolution of a portion of the continent and the evolution of one of its topographic features as shown by the Blue ridge. This evolution has gone on everywhere. Every ridge, however small; every valley, whether shallow or deep, narrow or broad; every stream channel all over the surface of the continent, has its history back in the past, and it is by the studies of the geologists that we learn something of that history. It is now nearly forty years

* See *Am. Journ. Sci.*, vol. xliv., 1892, pp. —

† See article on "The North American Continent during Cambrian Time," in "Twelfth Ann. Rep. U. S. Geol. Survey," 1892, pp. —

since William B. and H. D. Rogers discovered many elements of the structure of the Appalachian Mountains; but it was not until within the last few years that the means of correlating and thus interpreting more accurately the structure of the various mountains formed by the lower and oldest series of the sedimentary rocks have been obtained.

During the deposition of the 40,000 feet of sediments in the Appalachian trough many millions of invertebrate animals lived and died along the shore and on the sea bed. Those that lived in the earlier epochs became extinct and new forms succeeded them, and these in turn were succeeded many times during the vast interval between the first deposit and the closing one before the epoch of the last Appalachian uplift and folding. The remains of the various groups of life now afford the data by which the geologist correlates the various disturbed and often separated masses and determines what were their original relations to each other.

There are hundreds of local details yet to be studied and interpreted, and the work will be done by those who love to study the record of creation in the fragmentary book of nature, where all is written that we know of the past before barbaric man began his imperfect record by myth and legend.—*Nat. Geog. Mag.*

THE SPIRITS OF THE FOUNTAINS.*

By C. FALKENHORST.

WHO is not familiar with the numerous legends of overflowing wells flooding fields and villages and forming lakes? Such legends are widespread—one might say universal; for we meet them in widely separated regions, and even the natives on the shores of Lake Tanganyika, in German East Africa, have a legend that that mighty inland sea was formed by the overflowing of a spring, whose deity was offended by the disobedience of the people to her mandates. Such popular traditions are unquestionably based on facts; indeed, the threatened destruction of the town of Schneidemuhl, through the overflow of an artesian well, is a good illustration in point.

An attempt was being made to improve an old well by deeper borings. A spring was struck, but the water came up so mixed with sand that the boring was continued. The pipe was stopped, but the water forced a passage to the surface alongside of it, increased in force, and threw out great volumes of sand and earth. The discharge created a great cavern under a part of the town, and an attempt was made to fill up the discharge hole, but the angry water deities were not so easily appeased—houses were destroyed, and the homeless people are even now crying for help.

These violent eruptions of water, which have been traditionally ascribed to the anger of offended water spirits, have their explanation in changed conditions which determine the division and flow of subterranean waters. That "the fountains of the great deep were broken up" is part of the Biblical literature of the flood, and it has been suggested that not only the Noachic, but other floods described in legends were inaugurated by earthquakes. The historical period furnishes abundant records of changes in wells, and of great volumes of water upheaved by earthquakes. On the occasion of the great earthquake at Lisbon, November 1, 1755, there was such a violent eruption of water at the chief spring at Teplitz that in half an hour all the baths were under water. Half an hour before the outburst, the water ran muddy, it paused for about a minute, and then burst forth with wild violence, carrying a lot of red ocher with it. After a while the water subsided and flowed clear as before.

On January 12, 1862, the southern shore of Lake Baikal was subjected to a shock; the steppe to the eastward of one of its feeders, the river Selenga, then the site of a Burjack encampment, commenced to sink over an area thirteen or fourteen miles long and six to ten miles wide. Water rushed into the depression from all sides, and presently the water of the Baikal rushed in and filled up the whole hollow. Springs originated at several neighboring points; at Kudara the wooden framework over the wells was shot up like corks from an effervescent bottle, and in places warm water was shot up to a height of twenty feet. The Tartars were so frightened that they appealed to their "lamas" to inaugurate religious observances to appease the angry spirits.

But quite apart from the influence of earthquakes, subterranean waters may exercise an energy fatal to the people on the surface. Coming in contact with strata containing soluble salts, especially cooking salt, carbonate of lime, or gypsum, they dissolve these out, and thereby form enormous, ever-extending cavities. Bischoff found on examination that the water of the little river Pader, near Paderborn, contained one part of carbonate of lime in four thousand, and the discharge being calculated at a little over a million pounds a minute, accounts for the abstraction of two hundred and seventy pounds of carbonate of lime in that period, equal to the removal annually of a cubic block of the mountain, one hundred feet on the side. The Lorenz spring in Leukerbad brings up annually eight million pounds of gypsum to the surface.

The consequences of this action of water on subterranean strata containing soluble salts is clearly exemplified in the Karst mountains. The grottoes and subterranean streams of the region are among the most beautiful scenes in nature, but it is not good living over them; from time to time great areas of the surface sink, forming funnel and crater like hollows. These collapses are sometimes so sudden that many houses with their inhabitants are buried in the wreck.

The North German plains are rich in saline deposits, which in many places have been dissolved out, forming great subterranean caverns. Occasionally the surface falls in, forming surface depressions which, being filled with water, are converted into lakes. Similar conditions exist in Thuringia, and on the borders of the Hartz. Many of the lakes at the foot of the Hartz owe their origin to this cause.

But lakes sometimes disappear from the very causes to which we have here ascribed their formation. Rivers and lakes rest on impervious layers. If rifts open in these and let the water into deeper soluble strata, rivers and lakes will disappear. Such a catastrophe may follow an earthquake promptly. In the once flourishing region now occupied by the deserts of Western Asia, travelers have discovered the ruins of great cities, which were deserted by their inhabitants thousands of years ago. Traces of earthquake are still visible on the walls of the ruins. But men do not leave the homes they are attached to because an earthquake shakes them up a bit. They build again and again on the volcano. Other causes must operate, and so it was here. The earthquake cleft the surface, the water of the wells sank down to unreachable depths, the course of the rivers was diverted, and nothing remained for the survivors except to abandon the waterless region.

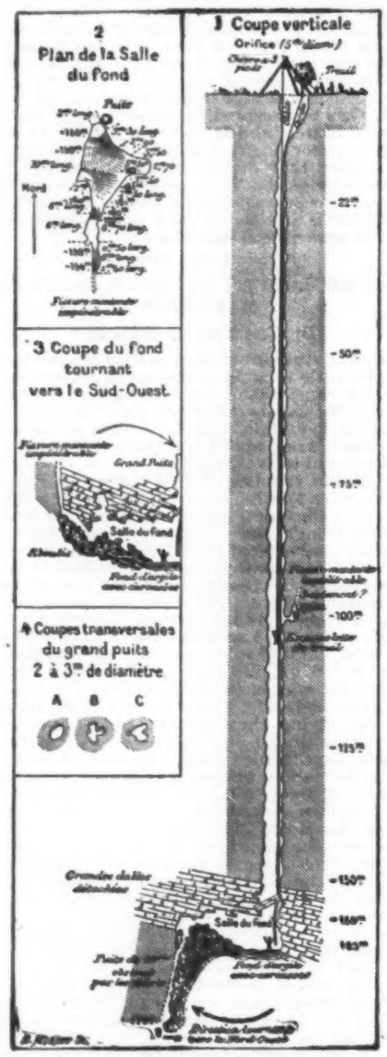
And what the earthquake may achieve at a stroke, the erosive action of water may achieve unaided in the course of centuries. Canals cut courses for themselves from the bottom of a lake, and to the astonishment of the dwellers on its shores the water suddenly begins to sink and ere long disappears.

Such an event occurred near Eisleben, not far from Schneidemuhl, only last year, and is still in operation. Slowly but steadily the surface of the sweet and salt lakes is sinking, and their waters are draining into the Mansfeld copper mines, which they threaten to submerge. An industry with 18,000 miners is fighting the water in the struggle for existence. Let us hope that they will be successful, as we have now reason to hope the people of Schneidemuhl already are.

* Translated and condensed for *The Literary Digest* from a paper in *Die Gartenlaube*, Leipzig, Halbheft 15.

THE ABYSS OF JEAN NOUVEAU (VAUCLUSE).

IN August and September, 1892, we entered upon a study of the origin of the celebrated fountain of Vaucluse, and, to this effect, explored several of the



THE ABYSS OF JEAN NOUVEAU.

abysses that open to the east upon the calcareous plains of the Ventoux and the Lure Mountain, and the infiltrations of which form and feed the source.

Without expatiating here upon this lengthy and complex question that we shall treat elsewhere in all its details, we merely wish to say a few words concerning one of the most extraordinary *avens* that we have met with up to the present, that of Jean Nouveau, which opens, at an altitude of 830 meters, 7·5 kilometers to the southwest of Sault (Vaucluse), and 23·5 kilometers to the northeast of the fountain, in the compact and fissured coral-bearing cretaceous limestones of the lower Aptian (ancient Urgonian).

Its depth is 165 meters, absolutely vertical. It is the greatest perpendicularity that we have descended up to the present. It is unnecessary to say that the exploration of it was long, difficult and dangerous. It produces a startling impression to see from the bottom the almost imperceptible light of day, the size of a star, at the top of this colossal tube. The accompanying section shows that it has the aspect of a true chimney, wider at the base (3 to 4 meters) than at the top (1 meter). The orifice has at first the form of a funnel 5 meters in diameter for a depth of 3 meters. At the depth of 150 meters, the ground changes nature. The stratification becomes visible at the same time with a manifestation of a caving in. At this level doubtless begin the Barremian limestones intersected by beds of clay (Upper Neocomian). The falling in must be due either to an earthquake (there was one in the region in 1812 and 1887) or to erosion through a nearby subterranean stream.

From the standpoint of the origin of natural wells, Jean Nouveau is particularly interesting. Four theories have been put forth to explain such origin: (1) Caving in (internal mechanical action);* (2) superficial erosion of absorbed torrential water (external mechanical action).† Widening of fissures in the earth; devil's kettles. (3) Chemical dissolution of the limestone by atmospheric air and water charged with carbonic acid (external chemical action);‡ chimneys of geyserian eruptions (internal chemical action).§

Geologists tend to abandon this latter opinion. Nevertheless, the form of Jean Nouveau will certainly serve as an argument to its partisans. To us it seems that the three other actions have all concurred to produce it.

The prime cause must be the crossing of two diaclases intersecting each other as shown by the fissure of the niche at 100 meters depth (Fig. 1) and that of the south (Fig. 2). The vertical line of intersection thus determined will afterward have been enlarged by the chemical corrosion of the infiltered acidish waters. Then the mechanical erosion of engulfed superficial running waters will have effected a further enlargement. It is revealed by the funnel at the top and by the internal groovings that the gyration of pebbles or rocks, carried along by the whirling fall of the stream, has dug out the earth spirally from top to bottom. Finally, the caving in of the bottom has occurred through one of the effects already indicated.

From the fact that the well is conical, point upward, it may be inferred that the liquid volutes have found an easy issue through the bottom. In fact, had there been a *cul-de-sac*, the column of water, after filling it, would have remained stagnant. The whirling would not have extended for a height of 160 meters and the interior would not be smooth and without spirals. On the contrary, owing to the internal escape, the cataract has been able to operate at its ease. Its live force (and that of the stones) increased with the depth, and has thus eroded the lower walls of the chimney so much the more energetically.

It is therefore nearly certain that free conduits are prolonged further down, unfortunately inaccessible on account of the caving in of the earth, and occupied perhaps by one of the thousand subterranean streams that all converge toward Vaucluse in consequence of the rounded form of the subjacent impermeable earth.

It would, then, be interesting to the highest degree, although very costly and difficult, to clear away the obstructions at the bottom. The problem of Vaucluse would thus doubtless make a great step, and, at the same time, it would be ascertained whether there is any foundation in the geyserian theory.—*La Nature.*

SYENITE QUARRIES AT ASSOUAN.¶

THE only place in the East where syenite, or pink granite, is found in quantity is at Assouan, and from this quarry came the columns of the Greek and Roman temples at Constantinople, Rome and Baalbec. To get the proper idea of the size of this quarry, which has been drawn upon for material by all ages, it is best to ascend to its highest point, and to bear in mind that the sands of the desert have covered its greater portion in later years. Near the top of the quarry is an opening containing a monolith 12 feet square and 100 feet long, detached and raised up, but not removed. In the long after years from the time it was detached, the attempt has been made to break the monolith in two by cutting a groove around it, but the brains and hands of the masters who detached and raised it were not there and the trial of simply breaking it was a failure. The quarrying of one of these monoliths was a work of time. The top of the quarry having been dressed off, the outline of the monolith was laid off. Around this outline a channel about two feet wide was chiseled and broken out to the depth of the monolith. This channel was cut with a gouge or half-round chisel, about half an inch wide. A grove six inches deep was cut on each side of the channel and the granite broken out between the two grooves. The chisel marks left on the side face of the quarry vary, but are about six inches high or deep. Some of the cuts are perfectly uniform, showing the good workman; while others are irregular, showing the apprentice's hand.

After the first cut was started, a second workman started in behind the first and took another six-inch cut; this process was followed by others till the bottom of the monolith was reached. All around the bottom of the block, square taper openings, three inches apart, about three and one-half inches high by five inches wide, were cut wedge-shaped about six inches inward, after which each hole was wedged and the monolith split off. These taper holes with their sharp square corners are a marvel. Any mechanic trying to cut a square hole through a piece of cold iron with a hammer and chisel will appreciate what it means to make these openings after he has broken some of his chisels. From the fact that the monoliths left in the quarries lie at an angle, it would appear as if they had resorted to tilting and blocking to elevate them. In the limestone quarries they took a cut about twelve inches deep, and much coarser, as the material, being softer, permitted the use of a longer chisel or gouge; but with this hard, tough syenite, they had to use shorter chisels and take finer cuts. There is nothing in Egypt to prove the use of copper tools in stonework, but they undoubtedly had good steel tools. The conquerors who succeeded the Egyptians, having nothing but fanaticism and insolence for their portion, could not make a pound of iron or steel, and from that day to this have been destroying the works of the old masters, to rob them of the iron used in their construction. The result is that even the tools of the ancient workmen have disappeared.

In Egypt all work is done sitting down. They turn table legs and all other woodwork on a lathe on the

* Abbot Paramelle, Tietze, Schmidl, Kraus, etc.

† E. A. Martel.

‡ Mojsisovics, Fuchs, Neumayr, etc.

§ Omalius d'Halloy, Scipio Gras, Bouvier, Lentheric, etc.

¶ Extracted from remarks made by John M. Hartman before the Franklin Institute, April 19, 1893.

ground. The work is revolved back and forth by a large bow, worked with the right hand, the gouge or chisel cutting only when the work revolves forward. The left hand guides the outer end of the gouge or chisel, while the inner end is held to the steady rest between the first and second toe of the right foot. The first and second toes of an old turner lengthen out beyond the other toes, and the space between them increases. They grow like the thumb and first finger, as they gradually assume their new functions.

CATTLE STRUCK BY LIGHTNING.

IN some parts of Oxfordshire the recent thunder storm was particularly severe and did considerable damage. At Shillingford, a little hamlet some two miles north of Wallingford, a group of nine cows, which had apparently sought shelter under a tree on the approach of the storm, were killed by the lightning. A correspondent sends us a photograph, from which the sketch was prepared, showing the scene of the occurrence shortly after the storm. The animals belonged to Mr. Shrubb, a farmer well known in the neighborhood.—*London Daily Graphic.*

CATTLE STRUCK BY LIGHTNING.

CHINESE INSECT WAX OR WHITE WAX.

A RECENT number of *Kew Bulletin* contains British consular reports on the above subject, of which that of Consul Baber is of much interest. We quote as follows:

A rush wick in a saucer of oil furnishes the common artificial light of the Chinese; but in all cases where a lantern has to be illuminated, or a light transported, or a votive offering made to a shrine, a candle becomes desirable. Animal tallow is very little used in Ssu-ch'uan, but an excellent substitute is obtained from the seeds of the Chuan-tzu shu and the Ch'i shu, two indigenous trees. The former is the well-known tallow tree (*Stillingia sebifera*), the seeds of which are boiled, and the tallow, floating on the surface, is skimmed off. The seeds of the Ch'i shu, or lacquer tree, yield a substance which resembles beeswax in appearance, and is freely used to adulterate that product.

The defect of these vegetable tallows is that they melt at too low a temperature. *Stillingia* tallow begins to run at about 95° F., and lacquer wax * at some nine or ten degrees higher, and it becomes requisite to procure a harder wax with which to coat candles made from them. For this purpose the famous insect wax, or white wax, of Ssu-ch'uan, which melts at about 160°, is employed; an article which has hitherto been the chief source of wealth to the population of the Chia-ting plain and the remote valley of Chien-ch'ang.

An unlucky accident prevented Baron Ferdinand von Richthofen from reaching Chien-ch'ang, but he succeeded in gathering from native informants an account of the wax productions, which, except for one or two unavoidable errors, is accurate enough. To save the trouble of reference and at the same time to explain my text, I quote his remarks:

"White wax (*Pe-la*). This is a very valuable and very interesting product of Ssu-ch'uan. It is largely consumed in the country, and much of it is exported to other provinces. The white wax of commerce is made exclusively in the department of Chia-ting Fu, near the western border of the 'Red Basin.' Ssu-ch'uan people know that it is also made in Shantung, Chekiang, and Fuh-kien, but speak with contempt of the wax of those provinces. According to my information none is made in Kwei-chow and Yunnan, or in any of the northern provinces. The department of Chia-ting Fu is a region where much level ground spreads between gentle hills, and bears, therefore, an exceptional character in a country so uniformly hilly as Ssu-ch'uan. Its climate is warmer than that of the plain of Ch'eng-tu Fu but not so warm † as that of the valley of Ning-yuan Fu, which is better known as the region of Chien-ch'ang and highly reputed for the beauty of its scenery. With admirable sagacity the Chinese have found that the breeding of this wax insect, and the production of the wax through it, are two distinct processes which cannot be combined profitably in one and the same locality, but if judiciously separated may lead to unexpected perfection.

* The lacquer wax is, of course, entirely distinct from the lacquer or varnish obtained from the same tree by incision of its trunk.

† The baron is not, of course, responsible for the opinion that Chien-ch'ang is warmer than the Chia-ting plain. In my experience it is 12 or 15 Fahrenheit degrees colder; being some 3,000 feet higher in level.

"The regions of Chien-ch'ang and of Chia-ting Fu divide the labors and the profits. In Chien-ch'ang, near the cities of Ning-yuan Fu and Hui-li Chow, the insect tree is planted, an evergreen tree with large and pointed ovate leaves. It is so valuable that it constitutes a separate article of property, distinct from the soil on which it grows. On this tree the wax insect lives and breeds, but secretes little wax. It is evidently under conditions best fitted for its healthy development. The wax which is made in Chien-ch'ang is just sufficient for the small local consumption and the supply of Yunnan. At the end of April the Chien ch'ang people leave their country in great numbers, each with a load of the precious eggs on his back, and travel on a very mountainous road to Chia-ting Fu, which they reach after a fortnight's arduous walking. The road is said to present then a very lively aspect, chiefly at night time, when they go with lanterns. The heat of the day must be avoided, because the sun would quickly hatch the eggs.

"These are described as a substance resembling flour, and contained in a bag of the size and shape of a pea. Three hundred of the little bags weigh one tael. They are eagerly bought up in Chia ting Fu, and immediately put upon the wax tree. This tree is said to produce no seeds in Chia-ting Fu, and to be easily multiplied by cuttings. It is not allowed to grow freely, but is kept short as a stump six or seven feet high. The shoots grow very rapidly. In the following year they serve for harboring the insect, and, as they must then be cut off, other twigs are allowed to grow in the third year. In the fourth wax is again made, and so on alternately from year to year. When the egg balls are procured they are folded up six or seven together in a bag of palm leaf. These bags are suspended on the twigs of the trees. This is all the human labor required. After a few days the insects commence coming out. They spread as a brownish film over the twigs, but do not touch the leaves. The Chinese describe them as having neither shape, nor head, nor eyes, nor feet. It is known that the insect is a species of Coccus.

"Gradually, while the insect is growing, the surface of the twigs becomes encrusted with a white substance; this is the wax. No care whatever is required. The insect has no enemy, and is not even touched by ants. In the latter half of August the twigs are cut off and boiled in water, when the wax rises to the surface. It is then melted and poured into deep pans. It cools down to a translucent and highly crystalline substance. Ten taels' weight of eggs produces from two to three catties of wax.

"The insect produces no eggs in Chia-ting Fu. The natives believe that the climate is not warm enough. It appears, however, that the plentiful secretion of wax indicates a sort of diseased state, owing, perhaps, to a too luxurious food. Where the insect breeds the secretion is much less, and the wax is of an inferior description. The wax trees are planted in fields, either on level ground or on the lowest portions of the slopes of hills. They are very plentiful in the districts of Omi, Chia-chiang, Hung-ya, and Lo-shan, all of Chia-ting Fu. Every attempt to produce good wax in other regions has failed."

Such is the baron's account. Since his report was published in the well-known "Letters to the Shanghai Chamber of Commerce," I have visited all the places mentioned above, and in the summer of 1887 I traversed the whole length of Chien-ch'ang. Its northern boundary is the Fung, or Ta-tu, River, in lat. 29° 20', and it extends southward to Chin-ch'uan Bridge, in lat. 27° 11'. It is not until the town of Lu-ku, in lat. 28° 13', is reached, that the valley becomes level and populous; north of that point a maze of passes and deep ravines seriously obstructs both cultivation and traffic, and affords every convenience to the border tribes for attacking convoys and caravans. The comparatively level part of Chien-ch'ang, through which the An-ning River runs, is the center of the egg culture, but there are besides many outlying spots in which it is successfully conducted.

The general opinion of the Chinese that wax cannot be produced in the districts where the insect is propagated, and conversely that reproduction does not take place in regions which are favorable to the deposit of wax, has led Europeans to suppose that the plentiful excretion results from a diseased state of the insect, brought about by its transportation to an uncongenial climate. But I soon found that the alleged incompatibility of wax making with breeding is accounted for in a much simpler way. No large deposit of wax takes place in Chien-ch'ang, because the eggs are carried away to other districts. No reproduction of the insect occurs in the Chia-ting plain, because the twigs of the trees are lopped off and boiled. It is clear that you cannot have wax if you exile the insects, and that you cannot have insects if you boil them down. But in Chien-wei-Hsien, on the Min River, where the conditions of climate, soil, and situation resemble those of the neighboring wax district of Chia-ting, both insects and wax are produced, separately, with perfect success; as is also the case in the Fu-lin Valley, immediately south of Ch'ing-ch'i Hsien, where the conditions are much the same as in the egg district of Chien-ch'ang.

I have twice visited the Fu-lin Valley, into which the wax production has only lately been introduced (in 1874 or 1875), and as the natives are very willing to give information about their new industry, I easily acquired a plentiful stock of fact and fiction. My second visit was in May, 1878, when the eggs had just been placed on the trees. The eggs are contained in a spherical gall of a dark brown color, a quarter of an inch to three-eighths in diameter, which is thin, hard, and brittle in substance, but becomes softer and slightly flexible when wet.

There is a more or less circular opening or breach at the point where the gall * was detached from the tree on which it was originally formed. Of such galls I opened forty or more, and found the less mature full of a white powder resembling wheat flour, but coarser, which acquires a yellow tinge as the time approaches for the birth of the insects. Each grain of this is an egg. In most of the galls which I examined the eggs were nearly all hatched, and the brood was actively crawling out through the circular breach. Every gall must certainly yield, on a moderate estimate, more than a thousand insects, for when these first march out into the world they are so exceedingly small that the unassisted eye can hardly detect individuals except under favorable conditions of light and color. Close and sustained scrutiny with a strong magnifying glass shows that they have six legs and a pair of antennæ, and that they are of two kinds, white and red, which it may be assumed are the two sexes. The white are reported to grow larger than the red, ultimately reaching the size of a sesamum grain. I suppose the red kind to be the female. What appears to be her alimentary canal is perceptible through her back, but the male is more opaque.

The natives affirm that one reason why the egg galls must be carried with all speed to the wax country is to forestall the ravages of the "wax dog," a parasite which, in their opinion, is formed in the gall along with the nascent insects, and soon devours them unless they are forthwith put to the trees. I was very eager to discover this insect cuckoo, but I found a specimen without any search in the first gall I examined—a white, oval, phlegmatic, obese, waxy, legless grub, about a hundred times as big as its victims, a terrible parasite indeed. It is called the wax dog on account of its supposed voracity, and sometimes the "wax buffalo" from its comparatively gigantic size. It lies in a bed of greasy fluff, encompassed by its prey. The second gall I opened also contained a buffalo; and so did the third, and so did the fourth, and so did every one I examined which contained anything at all. I had counted somewhere into the twenties, when in a gall of not more than average size came suddenly upon no less than six of these greasy monsters all ensconced together.

Insect life under such conditions seems scarcely worth having, if, that is to say, one's sympathies are on the side of the devoured. But by this time I had collected a whole herd of buffaloes, and, on comparing them, the backs of some seemed to be breaking out into ridges and plates, as if under a phase of transformation. It should be remembered that the galls which I was examining were in different stages of maturity, some being perhaps five or six days more advanced than others; the contents of some were barely hatched, while a few were mere empty withered husks; and in one of the latter I found, to my exceeding surprise and excitement, a jet black muscular beetle, which sprang actively from the husk, lifted its elytra, unpacked its wings and flew solemnly down the breeze before I could secure it.

Very possibly, therefore, the natives are right in supposing the buffalo to be an interloper; and yet I was for a long time persuaded that this waxy grub is the mother of the brood, and even now I am reluctant to abandon the belief. But according to all analogy the coccus mother ought to die some time before the young are hatched, and dry up into a mummy attached to the inside of the gall, which is a kind of carapace. Moreover, how is it possible to account for six mothers under the same roof? In any case it seems difficult to explain the presence of the beetle. He was much too large to have crept in through the breach, and apparently much too mature to have been developed inside in so short a time.

Such speculations and inquiries must be left to the professional entomologist. It is time to return to our red and white insects. The mother gall being placed upon a suitable tree, the young brood march out at a good round pace and ascend the branches, the red females leading the way; after a period of desultory wandering they reach the leaves, on which they seem to feed, but the quantity they consume is imperceptible, and the leaves remain to all appearance uninjured. In about ten days they return to the thin upper twigs, where, according to the natives, the males begin to excrete wax, and the females to form the galls either amid the wax or apart from it. The deposit of wax gradually increases until a hundred days from the date when the galls were attached to the tree, and the twigs are then almost entirely coated with a layer one-third of an inch or less in thickness. The whole process extends from the middle of May to the end of August. While still on the tree, the deposit is a kind of dense, greasy fluff, and looks very much like sulphate of quinine. The twigs, with their coating, are cut into convenient lengths and put into a pot with a little water. After boiling point has been reached the fire is removed, and when ebullition ceases the poorer quality of wax, with the hard parts of the insects and other impurities, sinks to the bottom. The

* "Gall" is an inaccurate term in this application, but it serves the purpose of description.

clear wax is skimmed from the surface and poured into a mould, where it solidifies into the wax cakes of commerce; the residue is turned into a bag through which it is squeezed, and yields an inferior quality.

The wax must be gathered in due season, for in the natural order of things the male ultimately extricates himself from the deposit and makes off. If they are allowed to escape, seven-eighths of the wax, I was told, would be lost.

The gall first appears as a small wart or barnacle on the bark, and gradually swells until February, when it has become a globe adhering to the bark by the lip of a circular orifice. The smaller the orifice the more productive, it is said, the eggs are likely to prove. At this stage the galls contain only a milky liquid; the floury eggs begin to form in March, and the so-called buffalo appears contemporaneously. In the Fu-lin Valley, where, as I have said, most of these facts and opinions were gathered, the galls are broken from the tree during the floury stage, and being folded up a dozen or so together in a broad leaf, usually that of the Fung-tzu (*Elæocarpus*), are tied to a branch of a neighboring tree. But nearly all the galls grown in Chien-ch'ang are conveyed to Chia-ting Plain, a few only being retained for purposes of reproduction. It is, of course, impossible to carry them while the contents are liquid; the milk would run out at the hole. Unluckily for carriers the interval between the milky and the hatching stage is short, and the young insects are just as prone to run out as the milk. Hence the journey has to be made with all possible dispatch; the carriers cannot march while the sun is high, for the heat would hatch the eggs. The stages must therefore be made by night, and every one must carry a lantern. It is also apparent that the whole body must set out within the same day or two, and since their average number is about fifteen thousand, all hastening by the light of their lanterns over some of the wildest passes and plateaux in the world, each eager to outstrip his fellow and get first to ferry or hostel, it will be easily imagined that their march is like the headlong flight of an army. The Fung River is more generally known in Western Ssu-ch'uan as the Ta-tu, or "Great Ferry," River, from its crossing by the egg carriers near Tu-lin. The spectacle of its passage during the egg season, as the ferrymen told us, "is more exciting than the slaughter of the rebels," alluding to the extirpation of Taiping hordes under the famous Shih-ta-k'ai, which was consummated exactly at this very spot in 1863.

Most of the carriers are natives of the Chia-ting district. The chief market to which they repair for the purchase of eggs is the large village of Te-ch'ang, on the right bank of the An-ning River, in lat. 27° 24'. Those who are unable to procure eggs, the supply of which is variable and not seldom insufficient, travel to Hui-li-chou and return with a burden of Yunnan opium. The egg carriers mostly take the route by Fu-lin and the So-i-ling Pass to O-mi-hsien, which is the shortest; others prefer to go by Fu-lin, the Fa-hsaing-ling pass, and Ya-chou; a certain number go round by Tung-ch'uan Fu; a few choose a circuitous way by Fa-chien-lu, which affords the advantage of coolness. On reaching the Chia-ting Plain the galls are attached to the trees with as little delay as possible.

Such is the history, so far as I could ascertain it, of the life and adventures of the wax insect. I cannot at any rate be in error as regards its shape and appearance. But on comparing the testimony of Mr. T. T. Cooper, the only other traveler who reports that he has seen the creature, a downright contradiction appears. He writes that near Wei-see, on the Tibeto-Yunnan frontier, he noticed for the first time the "white wax insect, which produces the famous so-called vegetable wax of Ssu-ch'uan. The branches of the smaller trees and shrubs along the road for a great distance appeared to be covered with snow from the quantities of these insects, resembling small moths of a very delicate white color, with a fluffy tail curling over the back."* So precise a statement cannot be questioned, and the account of the *fluffy tail curling over the back* is supported by what Dr. Wells Williams records of a similar insect. "The Peh-la-shu, or white wax tree, affords nourishment to an insect called Cicada cimbata. It is the larva which furnishes the wax. The fly was first discovered by Staunton on the coast of Cochin China; it has curious pectinated appendages on the back, and the whole insect is covered with a white powder, which is imparted to the stems of the plants it inhabits, and from whose bark it is collected by the natives."†

These descriptions differ so widely from what I saw of the Chien-ch'ang coccus, that there is no way of explaining the discrepancy unless on the supposition that Mr. Cooper's insect belongs to a totally different species. I am all the more disposed to accept this solution, since I observed in the groves round Chung-king certain kinds of bamboo in the autumn apparently splashed with whitewash, and found on close inspection that the phenomenon was caused by a kind of wax in course of secretion by a small insect provided with two plumes which spring from its hind quarters and wave continually over its back. But this wax is much too sparse and foul to be utilized commercially.

The production of insect wax, however, is by no means confined to Ssu-ch'uan. A wide field of inquiry awaits the explorer of this and many similar subjects. Baron Von Richthofen, as above quoted, cites Shantung, Chekiang, and Fuh-kien as provinces which furnish the product. The late Mr. Consul Markham found it in the Ningpo Hills, and from other sources I gather that it is grown in the Province of Honan, in the Island of Hainan, and in Japan. What may be the nature of the insects which furnish the various kinds can only be discovered by travel and leisurely observation, and it should not be prematurely assumed that they are identical with the coccus of Chien-ch'ang. Even in Ssu-ch'uan there is a distinct variety, of which all I can learn is that the eggs are attached to trees, as in the culture of white wax, and that oak trees only are suitable, for which reason the product is called Ch'ing-kang La, or oak wax. It is used for the same purpose as ordinary white wax, and is almost as hard, but acquires a brown color from the oak bark.

The tree on which the insects are bred in Chien-ch'ang is called the "Chung-shu," or insect tree, and that on to which they are transplanted in Chia-ting is known as the "La-shu," or wax tree; but either tree may be used for either purpose, and practically the two names are applied indiscriminately, except where precision of expression is attempted by natives of uncommon intelligence and experience. The insect tree is very common throughout Ssu-ch'uan, where it is also called "Pao-ke-tsao," a singular term, which means "crackling flea," and is said to be derived from a peculiarity of the wood, which, when burned, jumps and sputters in the fire. It is a handsome umbrageous evergreen, twelve or fifteen feet high, having glossy pointed leaves about three inches long, much resembling orange leaves, but thicker, and of a deeper green, with perfectly smooth edges. I have observed it growing among orange trees near Fu-lin. The leaf stems spring in pairs, and not alternately, from the central twig. I was too late to see the flowers, but a description of them is supplied by Captain Gill.

"These trees," he writes, "are in appearance like an orange, with a small leaf. They have a very small white flower, that grows in large sprays now (July 20), covered with masses of blossom, and a strong smell, which was not very sweet, filled the air."*

The wax tree of Chia-ting is kept polled so as to supply young shoots, and in this state it resembles a pollard willow, being reduced to a very ugly stump some eight or nine feet high. All over the Chia-ting Plain it is planted on the divisions of the rice fields, in such quantities that at 80 or 100 yards distance from the traveler, the trees close in upon one another, as it were, and shut out the view. The wax tree is deciduous. It has pointed ovate leaves of a light green color, smaller than those of the insect tree, with leaf stems springing alternately from the twigs.

Passages from native works referring to the trees have been extracted and translated by Professor Stanislaus Julien, and are reproduced in the "Univers Pittoresque" in the volumes which treat of China. The professor sums up his deductions in the statement that "the Chinese rear wax insects from three kinds (of trees), of which two are well known in Europe. They are the Nu-chen (Rhus succedanea according to Adolphe Brogniart), the T'ung-ch'ing (Ligustrum glabrum, according to A. Remusat), and the Shui-chin (recognized by A. Remusat as Hibiscus syriacus)." These natives names are† unknown in Ssu-ch'uan, but the description given above may perhaps aid botanists in judging whether they are justified.

The decline of so simple and curious an industry cannot be viewed without a feeling of regret, but the following figures show how the production and trade is failing. The export of eggs from Chien-ch'ang was—

In 1876 about 30,000 burdens.
" 1877 " 12,000 "
" 1878 " 1,200 "

A burden consists of 64 packets, each packet containing 18 Chinese ounces (or 24 English ounces) of eggs; but the heat of the journey hatching the insects *en route* reduces the weight by about one-third. One packet may be expected to yield nearly four *catties* (say five and a quarter English pounds) of wax. The production of wax has therefore been roughly—

In 1876, 10,000,000 lb.
" 1877, 4,000,000 "
" 1878, 400,000 "

The cost price of the eggs in Chien-ch'ang ranges from 6*l.* to 12*l.* per burden, and about 26*s.* per burden must be paid at various points for duty and excise. For sale on arrival the price varies between 10*l.* and 30*l.*

The market price of the wax in Chia-ting is about 9*l.* per hundredweight, having continuously fallen of late years. It is said that 20 years ago the price was as high as 70*l.* per cwt., but this seems quite incredible. There can be no doubt that the depreciation is consequent upon the enormous import of kerosene oil; but Chung-king merchants persuade themselves that it should be attributed to the invention of gas and its introduction into Shanghai.

(Signed) E. COLBORNE BABER.

Chung-king, June 10, 1879.

Revised and corrected, September 30, 1884.

(Signed) E. C. B.

NOTE.—The places mentioned above will be found in the map attached to my "Travels and Researches in Western China," published by the Royal Geographical Society. It will be useless to look for them elsewhere.

CARRIER PIGEONS.

By JOSEF V. PLEYEL.

OF late years the interest in carrier pigeons has been very considerably enhanced. Belgium takes the lead, but the other countries are not far behind. The facility with which the carrier pigeon determines its course is as yet unexplained. To attribute this knowledge of direction to instinct is merely a confession of ignorance. It is much rather sight, reflection and sensation which guide the carrier pigeon on its course, and rarely guide it wrong. The same faculty is possessed by all migratory birds. To form an intelligent conception of this faculty, we must assume either a special sense or a delicate sensitiveness to atmospheric currents. Experiments by balloonists have shown that pigeons are incapable of flying at any great height. Birds thrown out at 6,000 meters fell like dead, and even at the moderate height of 300 meters pigeons liberated by the balloonist, Gaston Tissandier, approached the earth in a spiral course. It is evident, hence, that they are not guided wholly by sight. To bring a point 300 miles distant within the range of vision, it would be necessary to ascend nearly 20,000 meters. The carrier pigeon, starting on such a journey, must consequently start with faith in the unseen.

As regards the speed of flight of carrier pigeons, there is considerable divergence of opinion. The Belgian birds are admitted the best, and the greatest achieved speed of a Belgian bird is given as 150 kilometers (over ninety-five miles) within the hour. In favorable weather a good bird will cover thirty to thirty-five miles in an hour. The greater the distance the smaller the probability of the prompt return of the bird. At a distance of say a hundred miles, almost all birds return safely if the weather is favorable, but at distances of four or five hundred miles it is impossible to reckon confidently on the bird's return. It appears curious, but it is a well-established fact that as the bird nears its home its speed is accelerated.

The question has frequently been raised as to whether the male or female pigeon is the better for racing contests. Practically there is nothing to choose between them when both are in condition, but a laying female should never be taken for the sport.

The carrier pigeon is not, as many suppose, a distinct variety. All domestic pigeons are presumably descended from the blue-rock pigeon, and all are more or less suited to the purpose. The common pigeon is not used, for, although a rapid flier for short distances, he has no great staying powers.

One of the best pigeons for the purpose is the tumbler (*Columba gyratrise*), whose sense or sensation of direction is very strongly developed, and who rarely loses his way. The tumbler flies higher than most birds of the genus, and will continue circling in the air for hours. He has all the necessary staying power for long flight, and a great love of his home. Still, many of these birds leave much to be desired. In the first place, they are likely to waste time before setting out on their return; again, they are liable to fall victims to birds of prey; and, lastly, they are especially liable to diseases of the eye, which frequently result even in total loss of sight. Another bird of equal speed and endurance is the Persian "carrier."

In the first year the trainer rarely lets the test exceed from 60 to 90 miles; the following year the distance may be extended to 250 miles; and in the third year, when the bird is at the height of his powers, the limit may be extended to 350 or 400 miles.

In the last year of training, the first flight is from 120 to 130 miles, terminating in a contest which usually extends to about 300 miles. The longest contests are from 400 to 700 miles. Before entering a bird for the contest it should be carefully examined as to its fitness, and the feet cleaned, washed, dried and oiled. Some trainers start their birds with empty crops, with the idea that it will make them more eager to get home. This is a great mistake. The famished bird is liable to be exhausted by long-sustained effort.—*Der Stein der Weisen; Literary Digest.*

HOW BIRDS STEER.

THE flight of birds still presents several unsolved problems. How they steer has never been fully explained. With the naked eye or, still better, with a field glass, many of them can be seen to use their tails, lowering the left or right side according to the direction in which they wish to go. This use of the tail as a rudder is much practiced by pigeons, jackdaws, rooks, larks, swallows, housemartins, sandmartins, and I believe by most of our common birds. Gulls let down a foot on one side or the other, and no doubt many other web-footed birds do the same. Still a rook or pigeon that has lost his tail manages to steer well, the chief result of the loss being that he cannot stop suddenly, nor float upon the air, but must take rapid strokes with his wings. What other method, then, has the bird of steering? One fact that bears upon this question can be easily observed. When a bird wishes to turn to the left he moves the center of gravity of his body and flings himself on his left side, the right wing pointing upward and the left downward. How does he throw himself into this position? Most writers say that it is by striking harder with one wing than the other. In turning to the left the right wing would give a vigorous stroke, and so raise the right side of the body more than the left. At first sight it seems as if this explanation could not be the true one, since after a hard stroke the right wing should be lower than the left, which has only given a gentle one, and yet it is the right wing that is raised. But we must not be too hasty in drawing conclusions from this. When the down stroke takes place the wings do not descend far; the body rises so that the end of the wing appears to have described a much greater arc than it has done in reality. If, then, with the right wing a much harder stroke is given than with the left, the right side of the body will at once be raised, and the whole bird will be thrown upon its left side, while the movement of the wing itself may not be enough to be perceptible. If birds are watched as they fly, one wing seems always to be at the same angle to the body as the other, so that a straight line connecting the tips of the wings would pass through the two shoulder joints, or be parallel to a line passing through them. Instantaneous photographs of birds on the wing seem always to me to bear this out. One wing may point up and the other down, but that is through the swaying of the whole body to one side or the other. In spite of this there may be an inequality of stroke that escapes detection, and without assuming this it seems on first thoughts difficult to account for the extraordinarily rapid turns made, for instance, by the swallow. But supposing that what appears to be the case is really so, viz., that equal force is put into both wings, there remains another possible explanation of this movement of the center of gravity to the left or right in turning. If a bird wishes to steer leftward, he may bend at the waist toward the left. So much has been said about the rigidity of the bird's backbone that its suppleness at a point just anterior to the ilium has been overlooked. I find that a swallow's vertebral column will bend at this point so as to form an angle of 150°; in the case of a kestrel it is 156°, of a tern 155°, of a sandmartin much the same as in the case of the swallow, in the case of a duck 165°; *i. e.*, a duck can bend much less at the waist than the other birds mentioned, and you have only to watch ducks on the wing to see that they are very poor steerers. This is but meager evidence, and, at present, I have not the means of collecting more. Still, as far as it goes, it seems to

* "Travels of a Pioneer of Commerce," pp. 323 and 429. On his return journey Mr. Cooper traversed the Chia-ting district, and he describes the method of wax culture. But as he passed through in October, two months after the wax had been gathered, his account must have been taken from hearsay only, and he seems too hastily to have assumed that the insect is of the same kind as he saw near Wei-see.

† "The Middle Kingdom," first edition, vol. I., p. 274.

* "The River of Golden Sand," vol. ii., pp. 62, 63.

† From inquiries in drug shops, however, I found that the berries of the Pao-ke-tsao are known as "false Nu-chen," and that "true Nu-chen berries," used in native medicine, are yielded by a tree named T'ung-ching. But the identification of the Chinese book names of plants with local names is hopelessly involved and obscure, and little can be gained by the most wearisome research.

show that suppleness of waist goes along with the power of swerving rapidly, and, *a priori*, it seems extremely improbable that such a highly acrobatic feat should be performed without calling into play every power that is available. Direct observation can, I fear, afford little help, since the feathers obscure any slight bend in the back. But the habit that many birds have—it can be easily seen in the case of gulls—of turning their heads in the direction in which they wish to go, suggests that it may be by bending the vertebral column at a point where it would be more effective that they make their turns, just as a skater changes edge and flies off on an opposite curve by swaying the weight of his shoulders across to one side or the other, a change of balance effected by a bend sideways at the waist. It is certain that birds do not depend entirely on movements of the head or neck, since gulls, for instance, may occasionally be seen to turn to the left while looking to the right and *vice versa*, a point which may be made out from instantaneous photographs. I cannot help thinking, then, that a bird avails itself of the suppleness of its waist to alter its balance when it wishes to turn. Whether this is the sole means, or whether at the same time the wings are worked unequally so as to conduce to the same end, is difficult to decide. I may add that I have found the required muscles at the waist considerably developed.—*F. W. Headley, in Nature.*

THE DISTILLATION OF ESSENTIAL OILS AND SEPARATION OF THE OIL FROM THE WATER.

By J. F. CHILD.

THE principle underlying the separator described below is this: A column of water 9 in. high will support a 10 in. column of oil sp. gr. of 0·900.

The separator is so arranged that there are two columns, which will both be of water if no oil be allowed to enter, but if sufficient does go in, one column will be of water and one of oil, with no possibility of their getting mixed.

Fig. 1 shows the chief features in the construction of such a separator. On pouring water into the funnel,

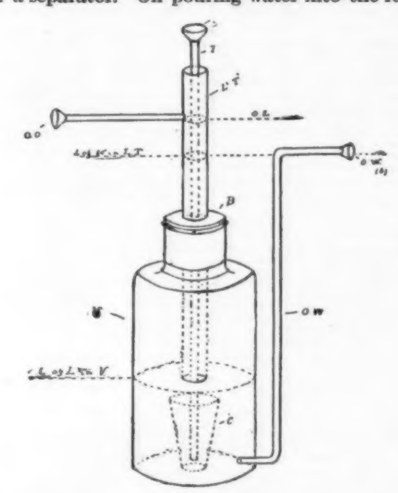


FIG. 1.

F, it is conducted down the tube, T, into the cup, *c*, which it soon fills, and if the supply is continued, the cup will overflow and the water will gradually rise in the vessel, V, until the bottom of the larger tube marked L T is reached. For the water to rise any further in the vessel there would have to be an outlet for the air, which there is not, as all egress from the bottom of the larger tube or cylinder to the top of the vessel is prevented by means of a tight-fitting bung, B; and thus the water is obliged to rise in the cylinder, L T. The water will rise in the water outlet, O W, at the same rate. It will continue to rise till the line marked L of W in L T (level of water in large tube) is reached, when all water added afterward finds an outlet through O W (*b*). Thus it will be seen that it is impossible for any water to run out of the arm, O O, even when there is only water in the separator.

If a light oil be poured into the funnel in the same way as the water was poured in, the oil passes down the small tube into the cup, from which it takes an upward course, and will gradually collect at the top of the large tube, L T, the water displaced by it finding a means of escape through O W. Before any oil can run out of the arm, O O, the tube, L T, must be full or nearly full of oil, when it will be found that the level of the oil has reached O L, at the same elevation as O O, and the oil will then be able to escape. If the supply of oil is continued, a point is reached when water ceases to run off, and only the oil passes out by the arm, O O.

Should the apparatus be proportionately constructed, it will be found that the oil only forms a slight layer on the top of the water in the vessel, V—a fact proving the principle to be correct.

There are difficulties, which are overcome as follows: The liquid sometimes lodges in the funnel of the model if poured in too quickly, and then trickles down the tube at a very slow rate, or perhaps passes down with a rush, violently agitating the liquid in the vessel, and also carrying down bubbles of air. These air bubbles are objectionable, because they are apt to unite with particles of water and carry them up the tube, L T, to the surface of the oil, where the air disengages itself and the water globules descend again.

The passage of air bubbles down the tube is continually taking place, even when the inflow is carefully regulated, for the fluid then circulates round, leaving an air passage all the way down the tube, in the same way that the water escapes down the waste plug of a fixed hand basin.

Perhaps of these two causes of the introduction of air, the former is the worse, as there is then a very strong upward current. However, the amount of water that finds its way out with the oil in the worst of cases is not more than 5 per cent.

The cause of the fluid collecting in the small tube and funnel is that the tube used in the model is, though in due proportion, too small ($\frac{1}{16}$ in. diameter), and capillary attraction no doubt accounts for it.

The following method prevents the possibility of water escaping with the oil:

Oil and air with the water are first conducted as they rise up a second inner tube, so that they may pass to the surface, separate, and the water fall back again without in any way contaminating the oil in the outer tube. The best way of arranging this tube is shown in Fig. 2.

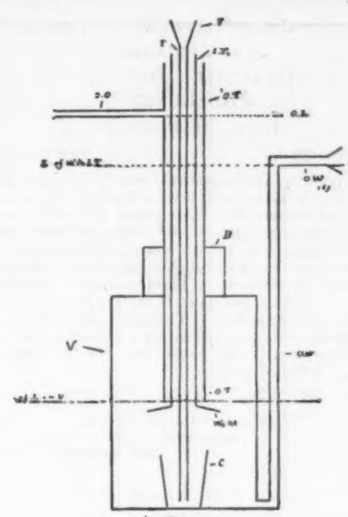


FIG. 2.

The action of the air after it enters this improved apparatus is as follows:

The bubbles rush down the tube, T, and emerge into the cup, *c*, from whence they take an upward course, and it is just about where the oil and water meet that the mechanical advantage is observed as regards the water globules. If the inner tube has a sufficiently wide mouth, W M, fitted to it, the air, water and oil are caught and conducted up the inner tube without injury.

No oil will be able to enter the outer tube, O T, until the inner one is full of oil down to the bottom of its mouth, when the oil will be able to escape round the edges of the flange, W M, and so into the outer one. Care must be taken that there is a fair amount of room left between the flange, W M, and the bottom of the outer or larger tube, O T, to allow the water and oil to change places easily; also to allow of the space between the top of the cup, *c*, and the bottom sufficient flange, W M.

Most essential oils, when distilled with water, behave vastly better than when only shaken with water, so that if the separator will "part" the latter in a satisfactory manner, it can hardly fail under the former condition.

If the separator is to act properly, the liquid must flow into it at a steady and regular speed. To provide for this it is proposed that a regulator should be used as is shown in Fig. 3. The water and oil enter the fun-

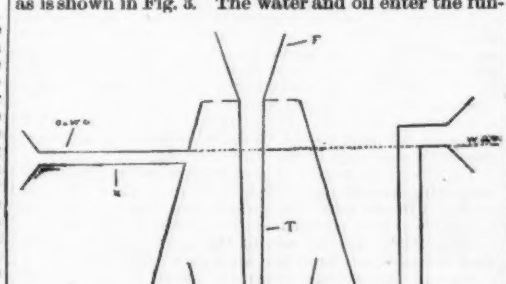


FIG. 3.

nel, F, go down the tube, T, into the cup, *c*, and then rise and flow out of the arm, O *a* W O (oil and water outlet), into the funnel of the separator. Should the liquid run into the funnel of the regulator (Fig. 3) quicker than it can get out of the arm, O *a* W O, the level of the liquid would be raised and the water from the bottom of the vessel would be able to escape through W O. By fitting O *a* W O with a tap—say at X—the supply could be easily controlled.

It will be seen that the effect of this preliminary treatment would be to allow the oil globules to unite somewhat and so form larger ones, get rid of an excess of water without danger of losing oil, and give a steady flow of liquid to the separator.

A few hints as to a suitable shape, etc., for the separator would perhaps be of use to those who intend to try it.

The arms, O O, in Figs. 1 and 2, and O *a* W O in Fig. 3, might be with advantage slanted down, in which case the lips would no longer be required. The same must not be done with the arms, O W, or W O, in Figs. 1, 2, and 3; they must be kept at right angles, or they would act as siphons. But a considerable improvement could be effected by doing away with these arms, W O, and substituting heads such as shown in Fig. 4, as they would answer to a rise of level in the vessel by letting out water quicker than the arms do. The lip may extend from the top of the tube instead of as shown in the drawing.

A means of raising and lowering either the oil or the water outlet is necessary to suit the specific gravity of the oil to be distilled. It would be best to alter the water column so that its length is proportionate to specific gravity of the oil. Thus to support 1 measure in length of oil sp. gr. 0·900, a column of water 0·9 in length is necessary, and so on. A screw arrangement to shorten and lengthen the water outlet is all that is wanted.

Before allowing any distillate to run into the separator and regulator both should be filled with water, and

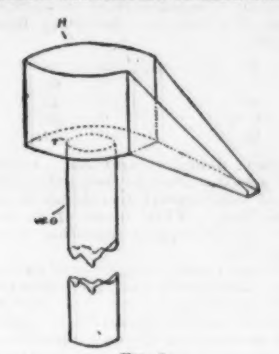


FIG. 4.

carefully adjusted on a perfectly level surface.—*Chem. and Drug.*

ABSOLUTE ALCOHOL.

By PETER WYATT SQUIRE.

ABSOLUTE alcohol, as described in the appendix to B. P. 1864, was obtained by a combination of the processes contained in the Edinburgh and Dublin Pharmacopœias, with a standard purity of 99·6 per cent. No change was made in 1867, except to introduce a preliminary dehydration with carbonate of potash previous to distillation over quicklime. In 1885, when absolute alcohol was transferred from "Articles Employed in Chemical Testing" to the "Materia Medica," the quicklime was replaced by chloride of calcium (a rather questionable improvement), and the standard of purity *lowered* to a permissible 98 per cent.

Besides its use as a preservative for chloroform, absolute alcohol has only one other official application—viz., the preparation of liquor sodii ethylatis—and it may be inferred that the strength and tests were fixed with this latter object directly in view. It has, however, been pointed out (*The Chemist and Druggist*, 1885, page 657) that the ethylate of sodium solution is sure to contain some proportion of ordinary sodium hydrate, and it is evident from a very simple calculation that if the alcohol contains the 2 per cent. of water allowed by the Pharmacopœia, it will be sufficient to at once convert nearly half of the sodium into hydrate.

As liquor sodii ethylatis is scarcely, if ever, used, the question of absolute alcohol may be considered by itself, and the following notes on the various proposed methods of testing (arising out of some experiments in connection with a new edition of the "Companion") may be of sufficient interest to justify their appearance here:

1. *Specific Gravity.*—This, of course, is the simplest test, but to be of much use it should be correct to the third decimal place. In absence of a Westphal balance, the most ready method is probably to weigh 250 c. c. with a balance turning to 0·2 gramme. In any case the temperature must be accurately noted, and the volume of the measuring flask checked by weighing with distilled water, as the graduations are not always correct.

2. *Anhydrous Sulphate of Copper.*—According to the B. P. an alcohol at 0·797—0·800 (99 to 98 per cent.) "does not cause anhydrous sulphate of copper to assume a decided blue color, even after the two have been well shaken together." These directions are far too indefinite to be of much value, the blue color depending so much upon the proportion of copper sulphate used and the time during which it is left in contact. Contrary to what might be expected, a fairly large quantity of the reagent shows the blue more quickly than a small quantity, although the latter after a time takes a deeper color.

Using 0·5 gramme copper sulphate to about 7 c. c. of alcohol in a 2 drachm or ½ oz. stoppered bottle, the following reactions are given:

95	per cent. alcohol, a distinct coloration in	1 min.
97	" " " "	4 "
98	" " " "	10 "
98½	" " " "	1 hour.
99	" " " "	24 "

The B. P. test should, therefore, read, "8 grains anhydrous sulphate of copper shaken in a small stoppered bottle with 2 drachms of the alcohol should not show a blue coloration within seven minutes."

Permanganate of Potassium.—In Allen's "Commercial Organic Analysis," vol. i., p. 55, it is said: "The presence of as small a proportion as 0·5 per cent. of water in alcohol is indicated by the pink color assumed by the liquid on introducing a crystal of potassium permanganate." This test is almost too delicate for any ordinary make of alcohol—99 per cent. being strongly tinged with red—but the reduction of the specific gravity by 0·001 (0·3 per cent.) is sufficient to prevent solution, and consequent coloration, so that in some cases it may be useful. It is unsafe, however, to trust to a "crystal" of permanganate, as these are occasionally covered with a thin film of oxide, invisible to the eye, but sufficient to prevent the coloration of alcohol containing 2 or 3 per cent. of water. The crystal should be powdered, or at least well crushed, before placing it in the alcohol.

Bisulphide of Carbon.—The solubility of alcohol in bisulphide of carbon was made the subject of a paper

by two German writers, an abstract of which will be found in the *Year Book of Pharmacy*, 1871, p. 157, with a table showing its application to the determination of water in the alcohol. With *absolute* alcohol bisulphide of carbon mixes in all proportions, but when the alcohol contains water a turbidity is produced when a certain proportion of bisulphide is added. The writers of the paper, however, do not seem to have worked with an anhydrous alcohol, so that their figures are incorrect.

A much more exact method of utilizing the reaction is to add to 1 c. c. of the alcohol under examination 5 c. c. of carbon bisulphide, and note the temperature at which, if clear, it becomes turbid on cooling, and, if turbid, at which it becomes clear on warming.

In working this test, the following figures may be taken as a guide:

95	per cent.	alcohol,	88° F.
97	"	"	60° F.
98	"	"	48° F.
98½	"	"	33° F.
99	"	"	21° F.

For accuracy, delicacy, and easy application this test is unsurpassed. The only objection is the disagreeable smell of commercial bisulphide of carbon, even when "redistilled." This, however, is removed to a great extent by prolonged digestion over shreds of bright copper foil.

One would like to see bisulphide of carbon in the B. P. appendix. Besides its usefulness as a test for water in lard, lanolin, iodoform, etc., it is the best test for precipitated sulphur, the quantity of impurity being at once evident on shaking the two together.

As one of the most common uses of absolute alcohol is as a dehydrating agent in microscopical work, previous to "clearing" in some essential oil or hydrocarbon, it may be noted that nothing below 96 per cent. will clear into xylol or benzol, or below 95 per cent. for unoxidized cedar oil. The strongest spirit at present commercially obtainable by direct rectification is just short of this—viz., 60° overproof, equal to 94 per cent. alcohol, sp. gr. 0·811-0·812.—*Chem. and Drug.*

THE INFLUENCE OF EXERCISE ON THE INTERCHANGE OF THE RESPIRATORY GASES.

By W. MARCET, M.D., F.R.S.

THE following is a summary of the contents of a paper lately read before the Royal Society.

1. It was shown that in three persons out of four who submitted to experiment there was a great tendency to a uniformity of figure for the oxygen *consumed* under similar physical circumstances (food, temperature, etc.), so that if the CO_2 expired fell, the oxygen absorbed rose, and *vice versa*; this was accounted for by assuming that an increase of CO_2 in the blood in the state of repose is produced at the expense of the O absorbed. The fourth person experimented upon exhibited no such tendency. The CO_2 expired and O absorbed rose and fell together, which was ascribed to the fact that he was still growing.

2. Experiments were made on the influence of exercise on respiration, which showed that if stepping exercise (stepping at the rate of sixty-eight times per minute) is taken after a period of rest, there occurs for a few minutes an accumulation of CO_2 in the blood; of course, the storage of CO_2 after exercise must be controlled by the normal amount of CO_2 produced in repose, and the kind of exercise taken; this storage would in the cold winter weather, and between one and two hours after food, continue for about eighteen or twenty minutes. In my case the volume of CO_2 retained in the blood amounted to a mean of 500 c. c. while stepping sixty-eight times per minute. The CO_2 in store is next given out in the form of a wave, which is renewed after a certain lapse of time, so that there does not appear to be in respiration under exercise a fixed relation between the CO_2 expired and the CO_2 left in the blood. With practice and training this relation would probably become more and more uniform.

The storage of CO_2 in winter and after food was found to exhibit a certain relation to the excess of CO_2 expired under exercise over the CO_2 expired in repose; but eighteen or twenty minutes after exercise had been commenced this relation failed to show itself any longer.

The ratio in question was the same with two different persons; but further experiment is required to determine whether this ratio can be looked upon as general; the mean relation found is shown by the figure 0·123; therefore, so far as the present inquiry goes, by multiplying this figure 0·123 by the excess of CO_2 given out per minute under exercise over the CO_2 expired in repose during the same lapse of time, the result will show the volume of CO_2 absorbed in the blood per minute.

3. After the exercise adopted in this inquiry had been followed by a complete repose of ten minutes, the CO_2 expired had returned to the normal in repose, but the volume of O absorbed per minute had considerably fallen, apparently owing to the blood having charged itself with oxygen during exercise, so that the first few minutes after rest was taken, the blood was in a condition to supply oxygen for tissue changes without taking it from the air breathed at the time. After half an hour's perfect rest following exercise the respiratory changes had returned to their normal state of repose, or nearly so, the oxygen absorbed still occasionally showing signs of being a little lower than before exercise had been taken.

GLANDERS.

IN a recent number of the new Russian journal (*Archives des Sciences Biologiques publiée par l'Institut Impérial de Médecine Expérimentale à St. Pétersbourg*, vol. i., No. 5) an account is given, says *Nature*, of the latest endeavors to secure protection against glanders. It would appear from the experiments here recorded that as a means of diagnosing glanders the "malléine" (extracted from cultures of the glanders bacillus) is of great value. On being inoculated into horses suspected of having glanders, and into healthy animals or horses suffering from some other disease respectively, the different effect produced was constant and very clearly defined. In the case of the former, the existence of glanders was indicated by a distinct rise in temperature, from 1·5° to 3° C., and the formation of a tumor, while in the latter the temperature did not rise, or only very slightly, and an insignificant tumor, or none at all, was produced at the place of inoculation. Innumerable experiments on horses by various investigators confirm these results, and as a proof of the importance which is attached to these researches, it may be mentioned that only last September a circular was addressed by the German government to the commanders of cavalry, ordering the injection of "malléine" into the horses of those regiments where cases of glanders were proved to have occurred.

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TABLE OF CONTENTS.